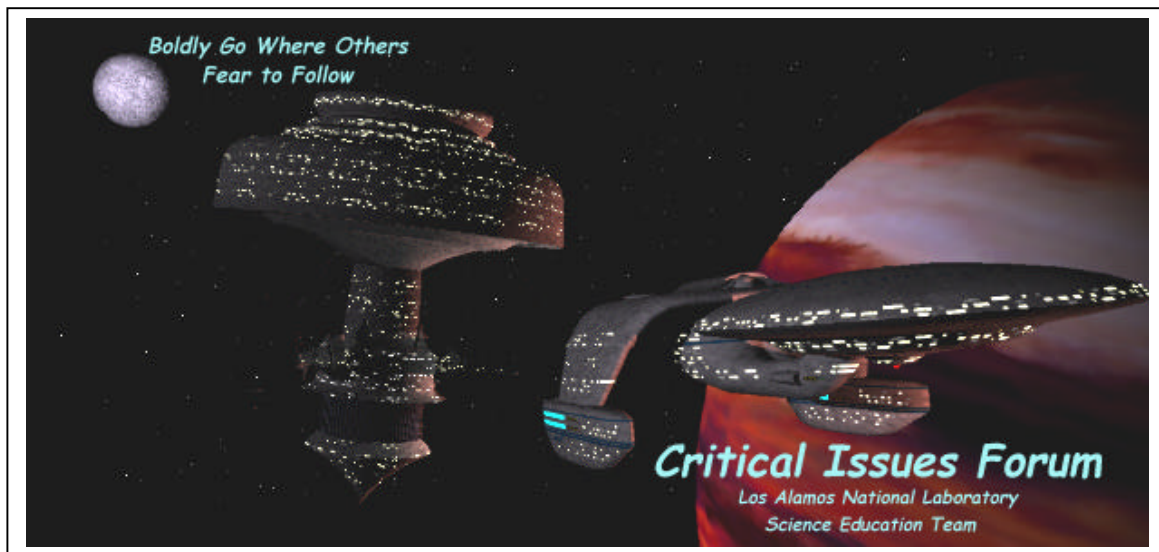


Critical Issues Forum

Students and Teachers
Examining Current World Issues



Join us as we investigate issues surrounding our
'Nuclear World'

Building a Historical Perspective of the Nuclear World
Terrorism in the Nuclear Age
Proliferation of Nuclear Weapons
Storage and Disposition of Nuclear Materials
Future Outlook for the Nuclear World

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Introduction

Reducing the Nuclear Danger is a primary mission of Los Alamos National Laboratory (LANL) and other DOE-DP laboratories with nuclear weapons containment as the heart of several programmatic goals. Major program activities in a variety of nuclear-related areas -- weapons, materials, nonproliferation, environmental restoration, and energy -- contribute to making the world a safer place.

The Critical Issues Forum (CIF) was established to give students and teachers the opportunity to address issues and circumstances involved in safeguarding nuclear weapons. As we first began to develop the CIF program, we made a conscious decision to develop a curriculum model that encompassed our educational philosophies and experiences as they pertained to successful teaching and learning practices. This model became the "Critical Thinking Curriculum Model (CTCM)."

We have developed challenging curricula in five areas focusing on the nuclear world. In addition, some of our former participating teachers have developed a few curricula areas based on the CTCM format. We hope you have a valuable learning experience as you participate in the topic area of your choice.

All of the nuclear world topic areas are inter-related and form the basis of five semester of work. Each curricula area requires teams of students to conduct academic research while they address specific task assignments. Completion of each assignment will prepare the students for the next assignment. The constructive nature of the program allows students the opportunity to build their knowledge base as they delve into real world issues. By the time students complete all the assigned tasks, they will have a much deeper understanding of not only the issue at hand, but also the world as a whole. As they investigate their chosen topic area, students will discover the connections between four domains, the scientific, the political, the economic, and the social/cultural.

A guiding principle of our efforts is perhaps best expressed by University of California, Santa Cruz, Professor John Schaar: "The future is not a result of choices among alternative paths offered by the present, but a place that is created-created first in mind and will, created next in activity. The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination." If we, as human beings, are to survive in the future we must make knowledgeable decisions about the directions we choose to follow.

Program Background

Data on teaching indicates that students don't learn science by absorbing information that has been given to them through lectures, but rather by constructing meaning out of experiences through opportunities provided by the teacher. Students tend to forget most of the facts given to them. Research based programs give the students the ability to retain these facts by affording them the opportunity to think critically, to work through problems logically, and to make connections to the real world.

Meaning is a human construction interacting with a social situation, we are constantly defining it for ourselves. But one must remember what John Dewey warned, to beware of regarding the child's point of view as "finally significant in themselves." (Dewey, 1902) Learning is the responsibility of the learner, but the teacher must guide the student into developing meaning from material and experience. That is why communication is so important, but not from a singular perspective. When a person can successfully explain a body of knowledge to others, we can say that this person has properly mastered this knowledge. In describing and explaining ideas to others, we need to communicate in a way that all listeners will understand as much as possible. We must realize that each listener will understand our words differently based on their previous experiences, thus these differences need to be considered.

Curriculum must be designed so that it reflects real life situations, especially in the area of science. So much fascinating science is at the fingertips of learners everywhere, and with the increase in affordability of technology, more and more is present in homes across America. The use of societal issues as an organizer for the science curriculum has been seen as a method of teaching science to counteract the concepts as distinct and unique disciplines of study. (Hofstein & Yager, 1986) Scientists in the real world cross over the barriers between disciplines all the time, and never operate solely in the area of science, but integrate the use of language, writing, content knowledge and application of processes.

The curriculum needs to be integrative and students need to apply their learning, and curriculum development should be "a complicated and continual process of environmental design." (Apple, 1995) There should be a multidisciplinary approach that includes the integration of subjects, which should emphasize education as a process and not a product. The teacher needs to assume the role of facilitator and guide students through the curriculum. In this approach, student interests can fuel the framework for facilitating scientific concepts. As stated in Science For All Americans, "Concepts are learned best when they are encountered in a variety of ways, for that ensures that there

are more opportunities for them to become embedded in a student's knowledge system."
(Rutherford, 1984)

An important insight in the design and development of curriculum and instruction is that content is nothing more nor less than a mode of thinking, a way of figuring something out, a way of understanding something through thought. There is no way to figure anything out without thinking. A typical school subject is seen as an area of content important to our society and the development of a "good" citizen. All content involves concepts and there is no way to learn a body of content without learning how to use it in thinking something through to a conclusive end. But content is also logically interdependent. To understand one part of some content requires that we figure out its relation to other parts of that content.

Content is currently approached as a sequence of "stuff" to be routinely covered and committed to memory. When content is approached in this lower order way, there is no basis for intellectual growth, no development of deep structures of knowledge, and no basis for long term grasp and control, thus no true understanding of the content.

Instructional practices in today's classrooms - presenting information, assigning homework, giving quizzes and tests, asking questions, and conducting class discussions - present a convenient framework within which to cultivate the process and practice of thinking. But thinking is only part of the equation of learning, building understanding. To be good at something requires "practice". Athletes know this and constantly strive for perfection by honing their raw abilities and talent through practice. Just as athletes practice to excel in their sport, students must practice to excel in thinking and learning. Curriculum must give students the opportunity to practice learning through thinking, questioning, and researching, to practice working with others to build a deeper understanding of content through collaborative efforts.

Program Goals

- To provide opportunities to develop and apply critical thinking and problem solving skills on a complex problem of global significance.
- To promote cooperative learning through successful teamwork.
- To develop the connections between scientific concepts and everyday life.
- To increase understanding of the science process.
- To increase public understanding of the issues relating to the future of the nuclear world.

Implementation of the Program

Students and teachers apply to participate in the CIF program as research teams. These research teams (teacher/s and students) participate as a class during the academic year. To take full advantage of the program, teams interact with other teams and with subject matter experts using telecommunications. Participating schools determine their needs for developing electronic networks with fellow student researchers and volunteer scientists and technicians or other experts. The schools provide support to the program by providing administrative resources and participation, by encouraging the teams to share their research with the student body and the community, and provide the students with an academic credit for completion of the program.

The project-based curricula approach developed for the program allows for a deeper search into a topic, whether it is terrorism, the future of "things nuclear", volcanoes in the universe, or macro-invertebrate analysis in local streams and rivers. The teacher guides the student in developing questions for further investigation, recommending resource sites, and probing student understanding of a given topic.

The teacher becomes a colleague, as students give direction to their research. Collaboration, whether it be in the classroom or through contacting subject matter experts via e-mail, is vital to motivating students and providing relevance to their classroom activities. Today, it may be as simple as a scientist at a national laboratory or institute of higher learning answering student inquiries about photosynthesis, tropical species or tornadoes.

Telecommunications use in the classroom empowers the learner to develop shared understandings of content material and to construct knowledge that is measurable by the classroom teacher. As Gowan stated, "The student's power to control better his later experience is grounded not so much in the teacher's authority as in the student's understanding of how educative materials enhance and enlarge the range of experience." (Gowan, 1981)

Problem-based learning, the Socratic method, and concept mapping can be seen as tools that help make student work more explicit and their understandings more complete. Yet, the project-based curriculum presents unique challenges to the teacher since it is often more interdisciplinary and open-ended in comparison to a traditional classroom experience. "Although the faculty will not be able to anticipate all of the ways students will shape what they learn (nor do they wish to), there are some principles and interrelationships they hope to highlight." (Edmondson, 1995)

Teachers have always provided the basic education, the 3 R's; reading writing and arithmetic ... but there is also a fourth R - research. To gain the full benefits of telecommunication, students must be involved in research activities that are real world centered and integrated with specific skill applications. The new language in schools includes terms like Internet, e-mail, World Wide Web, Telnet, FTP and networking. For the Internet "to be used in a meaningful way, we need to embed the use of this tool into a context; our teachers must guide its use and provide direction to set the stage for deep learning, and not for gathering of disjointed information." (Rose, 1995) To this end, we developed curriculum focusing on the "nuclear world" for the Critical Issues Forum program to act as a model for teachers as they develop and refine their curriculums.

A teacher can begin lessons by brainstorming with students to identify topics of interest to them, in order that they may direct their own learning and buy into the education process. "Relinquishing control of the curriculum will allow students to become responsible for their own learning as they manage projects, direct research and publish their work." (NetLearning, p. 119) By using sources across the globe, students can readily see (and many times hear) the connection to the real world.

The first thing you need is "a good curriculum" focusing on the desired content area. Designing an effective CTCM based curriculum appropriate to your grade level may take some time but the results will be well worth the time and effort involved. You will find that through the process of facilitating the discovery of content via a well planned CTCM based curriculum and not relying on didactic delivery of content, your students will learn, understand and retain more. As your students begin to actively pursue learning, they begin to take on the responsibility for their own learning.

Second, we recommend that a class of fifteen students or greater be established. This allows more interaction and affords you, the teacher the opportunity to establish multiple cooperative groups of 4 to 5 student members. Rules should be established relating to individual contributions to each group and to the class as a whole. It should be emphasized that the whole class is working together to resolve the problem that will be given to them at the onset of the semester.

Third, the class should emphasize learning as a process and not a product. The curriculum needs to be integrative and students need to apply their learning. The class should be a multidisciplinary approach that includes the integration of subjects allowing students to begin to make connections of their schoolwork to real life. The teacher needs to assume the role of facilitator and guide students through the curriculum.

Fourth, you should make sure that the students have access to resource materials, both "traditional sources" and "electronic sources." This will require access to the Internet. Each classroom utilizing a CTCM based curriculum should have computers connected to the Internet available for student use. This allows for immediate use when student groups have need for information. You should be prepared to facilitate any information search to expedite the process. Students should learn that the computer is a tool to be used in the learning process, but it must be available when needed.

Fifth, you will need to develop appropriate rubrics to be given to the students for their use in planning, monitoring and assessing their own learning. Explain to them what you are looking for in the way of group interactions, individual contributions to the team, research skills, writing skills, etc. and that you will be using the same rubrics to assess them. Have rubrics available for each area so students will know what to expect. The students must practice to improve their learning skills just as they practice to hone their athletic skills. Your class must give students the opportunity to practice learning through thinking, questioning, and researching, to practice working with others to build a deeper understanding of content through collaborative efforts.

Many teachers are now using project-based curriculum with great success at all levels of instruction. The discovery process mirrors the work done by real world laboratory scientists, and the dialogue generated by this type of inquiry helps to refine questions, interpretation of data, and new areas of research. The teacher cultivates student interests, but the ownership of the project is squarely on the students.

According to Bloom's Taxonomy, learning occurs in six levels. We call these levels the higher order thinking skills. It is the responsibility of the student to be engaged in their own learning by addressing all six levels. These levels are:

- Knowledge - the lowest level where students observe and recall information. This includes knowledge of dates, events, places, and major ideas and would include mastery of subject matter. It is the basis for the other five levels.
- Comprehension - this level includes understanding of information, grasping meaning, being able to translate knowledge into new context, interpret facts, compare and contrast, order, group and infer causes, and predict consequences.
- Application - this third level indicates that the student is able to use information, methods, concepts and theories in new situations as well as being able to solve problems using required skills or knowledge.
- Analysis - this level has the student seeing patterns, organizing parts, recognizing hidden meanings, and identifying components.

- Synthesis - students should be able to use old ideas to create new ones, generalize from given facts, relate knowledge from several areas and predict or draw conclusions.
- Evaluation - the highest level has students comparing and discriminating between ideas, assessing value of theories and presentations, making choices based on reasoned argument, verifying the value of evidence and recognizing subjectivity.

Students should be responsible for their own learning and make sure that they are addressing all levels. In addition to learning at all levels, students are also responsible for the following:

1. Being collaborative/cooperative team member
 - assuming an active role
 - working with the teacher and other team members
 - contribute to overall team effort and product
 - Participate in Socratic dialogue
2. Conducting needed research
 - Contribute to task analysis
 - Brainstorm and decipher assigned tasks
 - Make decisions toward task assignments
 - Conduct "traditional source" research
 - Conduct "electronic source" research
 - Collect data and information including sources
 - Report back to group for discussion
3. Maintain daily journal
 - Keep step by step process of research
 - Record ideas and questions
 - Record personal reflections
 - Record all information found and sources
4. Provide feedback to all teacher requests
5. Demonstrate acquisition of knowledge during and at end of class
6. Conduct self-assessments through teacher provided rubrics, etc.

By addressing the above, the student takes on an active role in his/her own learning. Through group interaction, the student learns to cooperate and make decisions that affect the whole. The student assumes responsibility for completion of his/her assigned task and then shares the results with the other team members thus contributing to the whole. As an active contributing member of a team, the student begins to see that he/she is making decisions about their own learning.

Introduction to the Tasks

The Tasks address the goals of the program by engaging the student/teacher teams in research, critical thinking, communicating thoughts, and making connections. The tasks also provide a mechanism for assessment, both for the program coordinators and the classroom teachers. Each task builds upon previous skills and knowledge base which allows the student/teacher teams to construct meaning from seemingly unrelated material. Each task addresses the interaction between the following domains:

Scientific domain

The impact of science permeates throughout society and provides many of the advancements in civilization. Along with the advantages science may produce, it also contributes factors that can be seen as harmful or detrimental to given situations. The purpose of this domain is to identify the scientific components within a given issue and to uncover the basic concepts present. Science has a great potential to benefit societies and people everywhere by increasing productivity while decreasing long term effects.

Economic domain

The effect of the economics is widely apparent in issues where those with the money and power create the reality in which everyone else must live. Too often, the lack of fiscal resources drives those in need to desperate situations that may lead to conflict. Developing an understanding of the underlying needs and motives of individuals and special interest groups that contribute to the economics with a given issue is to understand a major driving force in the decision making process.

Social/Cultural domain

The beliefs that people hold and the ties that bind them together are at the heart of this area of study. Within a critical issue, people's belief systems affect the way they interpret events and the reactions they have to situations and the ways in which they interpret information. Whether it be in a religious, ethnic or diversity issue, the impact of this domain on a given issue is real and ever-present.

Political domain

Politics make the world go round, and the varying regimes that dominate an issue, whether it be local, national, or global, impact the decision making process. Much of the political domain centers on the impact of political

systems and the identification of leaders and decision-makers. It is also an area where those that are involved in the process make the decisions that everyone else must learn to live with, and that without an awareness of the issues and the players, the chance to affect change is limited or nonexistent.

Each task is designed as an open-ended assignment allowing the student/teacher teams to explore and make sense of their world. The tasks provide the student/teacher teams an impetus to conduct research at a deeper level, requiring them to collaborate and question each other's thoughts. Each team then reaches a consensus, which is then submitted for publication on the CIF web site.

The tasks address objectives in the following areas:

- critical thinking,
- research skills,
- communication skills,
- scientific process,
- interdisciplinary nature of the issue,
- community involvement.

Select a topic area and proceed with the assigned tasks in sequence.

Building a Historical Perspective of the Nuclear World

During this semester, students will build a historical background of how the world arrived at this point in time regarding nuclear science. Before students can make decisions regarding the futures of nuclear things, they must be well versed in what led to our present situation and confrontations. Students will examine a number of questions while considering the four domains.

Task #1 - The Early Years - focus on pre-1800

Task #2 - The Golden Age of Science - focus on early and mid-nineteenth century

Task #3 - The Era of Hope and Promise - focus on late nineteenth and early twentieth centuries and the discovery of radiation

Task #4 - Splitting the Atom - focus on early to mid-twentieth century

Task #5 - The Manhattan Project - focus on mid-twentieth century and Manhattan Project

Task #6 - Beginning to End of the Nuclear Cold War - focus on Cold War Era and its legacy

Task #7 - Preparing for the Student Conference on the Nuclear World

Terrorism in a Nuclear Age

During the semester, students will build an understanding of the issues surrounding the topic of terrorism. Students will examine the many facets of this global issue through a series of open-ended tasks.

Task #1 - Foundations of Terrorism

Task #2 - Types and Methods of Terrorism

Task #3 - Motivation and Making Sense of Terrorism

Task #4 - The Media and Terrorism

Task #5 - Security and Monitoring

Task #6 - Future Outlook

Task #7 - Preparing for the Student Conference on the Nuclear World

Proliferation of Nuclear Weapons

During this semester, students will build an understanding of the issues surrounding the topic of proliferation vs. nonproliferation. Students will examine the many facets of this global issue through a series of open-ended questions.

Task #1 - Motivation for proliferation or nonproliferation

Task #2 - Technology

Task #3 - Global Concerns

Task #4 - Future Solutions

Task #5 - Preparing for the Student Conference on the Nuclear World

Storage and Disposition of Nuclear Materials

During this semester, students will build an understanding of the issues surrounding the topic of radioactive waste materials. Students will examine the many facets of this global issue through a series of open-ended questions.

Task #1 - Use of Radioactive Materials

Task #2 - Types of Radioactive Waste

Task #3 - Issues and Concerns

Task #4 - Laws and Regulations

Task #5 - Options

Task #6 - Preparing for the Student Conference on the Nuclear World

The Future of the Nuclear World

During the semester, students will build an understanding of the issues surrounding the topic of the nuclear world's future. Students will examine the many facets of this global issue through a series of open-ended tasks.

Task #1 - focus on current nuclear events

Task #2 - focus on future world environments in general

Task #3 - focus on future world environments, specifically energy

Task #4 - focus on role of nuclear things in future world environments,
specifically weapons

Task #5 - focus on role of nuclear things in future world environments,
specifically medical, industrial, and other applications

Task #6 - focus on public attitudes and institutional responses to technology in the
future with emphasis on nuclear things

Task #7 - Preparing for the Student Conference on the Nuclear World



Building a Historical Perspective of the Nuclear World

Introduction

A little over 50 years ago, work at Los Alamos and elsewhere in the world set in motion developments in military and civil applications of nuclear science and technology. Over the years these ongoing developments have shaped history. The resulting “Nuclear Age” has had a significant impact on many aspects of society -- nationally and internationally.

The Manhattan Project of the “Second World War” represents the most remarkable congregation of scientific minds in human history. New scientific ground was broken which helped to produce numerous additional discoveries. Modern computer theory largely grew from bomb-related research with the first huge mainframe computers being used mainly for bomb design.

Dramatic global political changes, including the end of the Cold War, provided opportunity and incentive for thoughtful examination and application of the nuclear enterprise. The continuation of research at Los Alamos National Laboratory after the war was intended to explore and expand the evolution of “things nuclear”.

But the mixture of innovative technology, institutional factors, and policy decisions that govern the nuclear industry did not begin with the creation of the Manhattan Project. Today's world has a past, sometimes ominous, sometimes frivolous, but always connected to future. As George Orwell once said, “He who controls the past controls the future. Who controls the present controls the past.”

Our attempts to create a historical curriculum are motivated by the practical need to tie long-range objectives back to near-term actions and decisions through achievable steps and milestones. A second principle guiding our efforts is perhaps best expressed by University of California, Santa Cruz, Professor John Schaar: “The future is not a result of choices among alternative paths offered by the present, but a place that is created-created first in mind and will, created next in activity. The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination.” What paths were taken that have led to our present situation? What conditions, economic, political, social/cultural, led people down the path that resulted in the development and deployment of the first nuclear weapons?

Exactly where our current situations may lead us, of course, is not known, but it is certain that the future has been shaped both by unanticipated events and intentional actions from the past. Our task, then, is to think broadly about what was desirable and possible without abandoning the realm of possibility for tomorrow. We can not change the past, but we can learn from it.

In this spirit, this Critical Issues Forum Project curriculum does not attempt to lay blame on past endeavors but rather to explore alternative reasons and their implications that led to them. In doing so, we hope to gain a deeper understanding that will guide our own actions as well as provide information relevant for current and future policy dialogues.

We've chosen to address a rather expansive 10,000 year period, a realistic boundary given that technology development and implementation generally took centuries due to political and religious realities.

March 17, 1996 was the 50th anniversary of the Acheson-Lilienthal Report, which began efforts to place all applications of nuclear science and technology under international control. Such international control did not come to pass. During the ensuing 50 years, a fabric related to nuclear affairs, civil and military, has been woven from threads of bilateral, multilateral, and international arrangements. The implications for mankind of the potential-for good and ill-of the energy of the nucleus of the atom are still global, indeed more so today than in 1946. The fact that this potential will continue to be a major issue in world affairs is the driver for our developing an understanding of the past.



Task Assignments for Building a Historical Perspective of the Nuclear World

Task #1 – The Early Years

*“...our eyes once opened,...we can never go back to the old outlook....
But in each revolution of scientific thought new words are set to the old music,
and that which has gone before is not destroyed but refocused
-A.S. Eddington*

A long time ago, in a far away world, a world of beauty unscathed by machines, a small band of early humans scoured the land in search of food and shelter. The days were dry and hot, the nights cool and clear. Early evening on a particularly clear night, lit up by a full moon, one inquisitive member of the band stood on the edge of a cliff looking at the bright orb that seemed only inches away. Reaching out to grab the bright object, the creature fell to its death. What made it reach out? Did it not know that the moon was a quarter of a million miles away? What might the other members of the band have thought? Would they too try to reach out and grab the moon?

From early civilizations to the present, humans have endeavored to understand their surroundings. These endeavors have led to great discoveries that have changed the course of history and of humankind. Throughout history (and pre-history), people have tried to control nature, to explain it in simple terms, to influence the world around them. This task takes us back to an earlier time to investigate ancient beliefs and to begin to formulate an understanding of the development of modern science, economics, politics, and social/cultural groupings

“Mine is the first step and therefore a small one, though worked out with much thought and hard labor. You, my readers or hearers of my lectures, if you think I have done as much as can fairly be expected of an initial start. . . will acknowledge what I have achieved and will pardon what I have left for others to accomplish”

- Aristotle

Your first task is to compare and contrast the endeavors of science and technology during two early time periods. The first period, 8000 B.C. to 1400 A.D. and the second period being the Renaissance period up to 1800. Using these as reference points, focus your research in relation to the two time periods

You must examine events that established the foundation corner stones from which science and technology today is based. Scrutinize these events in the context of the time periods. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the dawn of science and technology.

- Compare the thought driving the understanding of the world in each of the time periods. (What is science as it would have been defined during these periods? How is it different from other ways of thinking? How does it differ from technology of the time?)
- Describe the “scientists” of the time? (How did they think and what was their approach in explaining their physical world?)
- Describe the development of technology (cite examples) from these time periods. (How did technological advances affect the science of the day? How did scientific advances affect the technology of the day?)
- Describe how the political and social environments of the day (cite examples) impacted the pursuit of science and the development of technology?
- Compare the attitudes toward scientific endeavor in the western civilization with the eastern civilization and describe how these attitudes affected the advancement of science and technology? (Compare the differences in the two civilizations that produced unique approaches. How was each civilization affected as each neared the nineteenth century?)



Suggested Classroom Activities for Task #1

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on two time periods. The first period, 8000 BC to 1400 AD and the second period being the Renaissance period up to 1800. Using these as reference points, address the following in relation to the two time periods:

- 1.** Have a mock class dialogue between Aristotle and his students. Have your students identify possible members of Aristotle's class. Assign one student the role of Aristotle. Students should prepare themselves to act, as they would have during Aristotle's time. Each student might present "visuals" which capture and categorize their ideas while convincing the other members of their point of view. Be sure to consider the four domains (political, scientific, social/cultural, and economic) in developing.
- 2.** Develop comparative charts or database identifying new technologies of the time. Refer to each of the domains (How did the new technology affect each domain?).
- 3.** You are one of the "members of a campaign management team" for one of the Greek nations. As part of the political process, you are tasked to help the King select a new science advisor. The two main candidates are on opposite sides when describing the physical world. As a campaign management team, you must come up with a position on the following questions: What is the world's perception of the natural geological and meteorological occurrences? Are intelligence and communication skills a determinant of great power status? What power does a science advisor really have? Do we really need to understand the essence of life, where rain comes from, ...? What responsibility do we have to the general population? What are the benefits of understanding our physical world for our nation? The risks?
- 4.** Prepare campaign materials like brochures, bumper stickers, position papers, and TV and newspaper ads defining your ideas on the future of your nation's development of explanations of the physical world. Refer to the four domains.
- 5.** Your firm has been hired as consultants to the government. You must prepare a report on the impact of developing reasoned explanations for the physical world. You must answer the following questions: Why would you want to understand the physical world? What benefits would this have for the citizens of your nation? Would the world be a better place if we understood the physical occurrences? Would this be a realistic goal? What kind of infrastructure is needed to develop and disseminate reasoned explanations to the populace? What will it cost? What sacrifices would need to be made? How will it effect our national status? Can you truly be considered a great civilization today without

reasoned explanations for the physical world? How could our new reasoned capabilities be exploited within the framework of existing treaties and current power structures?

6. As a study group within King Arthur's scientific society, you have been researching the legacy left by the development of bow and arrow, including errors and accidents including their use in "Holy Crusade". Your present task is to develop a strategy for disseminating the results of your research. Design a plan for transferring this information to your outlying regions.

1. Brainstorm, capture and categorize issues you feel would be relevant motivators for a nation to pursue/not-pursue a reasoned explanations of the physical world

2. Brainstorm, capture and categorize questions that need to be explored

3. Develop comparative charts or databases identifying explanations of;

- thunderstorms
- solar eclipses
- earthquakes
- the common cold
- creation of gun powder
- transmutation of a caterpillar to a butterfly
- a fever

4. Develop arguments that could have been used by the "Wizards" for failure to control the weather (work within the constructs of the four domains)

5. Considering that "Wizards" of the "Dark Age" were considered indispensable to the rules of the nation states, determine the significance of the following:

- What is the world's perception of solar eclipse?
- Is the "power of a Wizard" a determinant of great power status?
- What power does a "Wizard" really have?
- What challenges did nations/the world likely face during the "Dark Ages"? (keep in mind the four domains)
- What were the lessons learned during each of the two time periods?
- What are the effects of these lessons on newly developing scientific theory?
- How can these lessons learned be transferred and applied without political repercussion?
- What have we learned from these studies?

The following questions are added to help build a deeper understanding that the "work of great scientists and mathematicians" did not occur in a cultural vacuum, that their work was impacted and had an impact on those that came before and after them.

1. What does the term "Metonic cycle" mean? What significance does it have in the history of science and mathematics?
 2. The "Merton College Theorem" had considerable importance in the work of Galileo and Newton. See if you can find out how and why.
 3. If trigonometry was "reborn" in about 1464, when was its "first birth"?
 4. What is the mathematical process called a "method of infinitesimals" and what special place does this idea have in the history of mathematics and science?
 5. The eighteenth century saw some of the earliest works on probability theory, chance, and gaming. What is the connection among these three things?
 6. What is "scholasticism" and what is its role in the development of science in the Middle Ages and later?
 7. Dante's Divine Comedy is essentially a work of literature. What significance does it have as it pertains to the sciences?
 8. In what ways was Descartes' Principia like Newton's Principia? In what ways were they different?
 9. In 1698, Thomas Savery received a patent on his steam engine, and yet it was more than a quarter of a century later that James Watt made the steam engine commercially efficient. What caused the delay in its widespread use?
 10. What is meant by the term "alchemy"? What can you learn about its development up to the Middle Ages?
 11. What do the fates of Priestley and Lavoisier tell us about the relationship of science to the politics of a society?
 12. In 1543, Vesalius published De Humani Corporis Fabrica. Why is this book regarded as a turning point in the history of biology?
 13. The experiments of Redi, Needham, and Spallanzani in 1668 were all directed toward answering the same question. What was the question and to what conclusions did each of these men come?
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Task #2 – The Golden Age of Science

"Fortunately science, like that nature to which it belongs, is neither limited by time nor by space. It belongs to the world, and is of no country and no age. The more we know, the more we feel our ignorance; the more we feel how much remains unknown....."

-Humphry Davy
November 30, 1825

Sometimes called the Golden Age of Science, an era when science seemed to be at the forefront of human activity, the 19th century was a time of major breakthroughs toward deeper understanding of the physical and life sciences. It was a time when science came into its own and commanded the attention of society. Science of the time gave impetus to technology, new perspectives to social understanding, and stimulated the arts. It was a time when scientists discovered approaches outside of the scientific method.

This task area focuses on the Golden Age of Science, 1800 to 1885. This period marks the dawn of a time when expanding scientific knowledge and technological advances virtually created the positive, can-do spirit of the Victorian era. But all was not rosy, undercurrents resisting change existed throughout the century.

Your task is to compare and contrast the endeavors of science and technology during the early to mid-years of the nineteenth century.

You must examine events that began to establish the corner stones from which nuclear science and technology grew. Scrutinize these events in the context of the time periods. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the "Golden Age" of science and technology.

This task focuses on the Golden Age of Science, 1800 to 1885. This period marks the dawn of a time when expanding scientific knowledge and technological advances virtually created the positive, can-do spirit of the Victorian era. Using this as a reference point, address the following in relation to the time period:

1. Compare and contrast the evolution of science in the nineteenth century to earlier centuries? How does it differ from the evolution of technology during the same time periods?

2. Politically and economically, the sense of the period was not universally positive. How did the political and social environments of the day (cite examples) impact the pursuit of science?
 3. What was the impact of the industrial revolution on the advancement of science and technology. Discuss the differing views toward the growth of science and technology during this period of time.
 4. Explain why science moved toward specialization into specific disciplines and subdisciplines (i.e., chemistry, physics, astronomy, biology, organic chemistry, and genetics).
 5. Sir Issac Newton wrote in an earlier time; "I wish we could derive the rest of the phenomena of nature by the same level of reasoning from mechanical principles, for I am inclined by many reasons to suspect that they may all depend on certain forces." What did Newton mean by this statement and what affect did such thinking have on science during the nineteenth century?
 6. The English poet, John Keats wrote that he was "certain of nothing but the holiness of the hearts affections, and the truth of imagination. What the imagination seizes as beauty must be truth..." Explain the affect that such romanticist writing had on the scientific endeavor during the nineteenth century.
 7. The idea of an unsplittable particle was first conceived by a 5th century Greek thinker named Leucippus. Trace the evolution of the concept of atoms from Leucippus to John Dalton.
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Suggested Classroom Activities for Task #2

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the time periods known as the "Golden Age of Science", from 1800 AD to 1885 AD Using this as reference points, address the following in relation to the time period:

1. Have a mock debate between three prominent nineteenth century scientists discussing the importance of the principle of the conservation of energy. Have your students identify possible scientists to role-play. Assign one student the role of moderator. Each student should prepare himself or herself to act as they would have during Victorian time. Each student might present "visuals" which capture and categorize their ideas while convincing the other members of their point of view. Be sure to consider the four domains (political, scientific, social/cultural, and economic) in developing arguments.
2. Develop comparative charts or a database identifying new technologies of the time. Refer to each of the domains (How did the new technology affect each domain?).
3. Your firm has been hired to prepare a report on the impact of new scientific discoveries for the general populace. You must address the following discoveries within the context of the four domains:
 - hybridization of wheat
 - observations of the digestive system
 - identification of the nucleus of a cell
 - cell theory (both plant and animal)
 - antiseptic procedures
 - non-Euclidian geometry
 - classification of clouds
 - reconstruction of fossils on basis of skeletal fragments
 - wave theory of light and heat
 - electromagnetic induction
 - principles of photography
 - speed of light
 - organic chemistry

Why is it important for the general population to know about these new scientific discoveries? What benefits would these discoveries have for the citizens of your nation?

What kind of infrastructure is needed to develop and disseminate reasoned explanations for these discoveries to the populace?

4. As a study group within Queen Victoria's scientific society, you have been researching the legacy left by previous scientific discoveries. Your present task is to develop a strategy for disseminating the results of your research. Design a plan for transferring this information to your outlying regions.

The following questions are added to help build a deeper understanding that the "work of great scientists and mathematicians" did not occur in a cultural vacuum, that their work was impacted and had an impact on those that came before and after them.

1. What is projective geometry?
 2. When Laplace spoke of a "Devine Calculator", he was simply articulating a widely held view of the state of physics in his lifetime. What was that view? Do we hold it still today?
 3. What was the reaction of the medical profession to the suggestions about antiseptic procedures in hospitals during the early nineteenth century?
-

Task #3 – The End of Hope and Promise

"The problem does not appear so hopeless when misleading metaphor is discarded. It is not our task to probe; we learn what we do learn by awaiting and interpreting the messages dispatched to us by the objects of nature. And the interior of a star is not wholly cut off from such communication. A gravitational field emanates from it... Radiant energy from the hot interior after many deflections and transformations manages to struggle to the surface and begin its journey across space. From these two clues alone a chain of deduction can start which is perhaps the most trustworthy because it [employs] only the most universal rules of nature - the conservation of energy and momentum, the laws of chance and averages, the second law of thermodynamics, the fundamental properties of the atom, and so on."

-A.S. Eddington, 1926

Throughout much of the western hemisphere, the twentieth century was seen as the dawn of an era of great hope and promise. The hundreds of discoveries and inventions made during the preceding century - the fruits of science and technology - seemed to open up a vast treasure of possibilities in the latter part of the nineteenth century and the first few years of the 1900's. Edison lit up the world. The Impressionists painters, freed by the invention of photography to explore and investigate new artistic techniques as they perceived rather than portrayed nature. Expanding horizons for individuals came into view at every turn.

radiation - n. 1. The act or process of radiating. 2. Physics. a. The emission and movement of waves, atomic particles, etc. through space or other media. b. The waves or particles that are emitted.

radioactivity - n. 1. The spontaneous emission of radiation, either directly from unstable atomic nuclei or as a consequence of a nuclear reaction.

-The American Heritage Dictionary

In science, at the turn of the century, a veritable burst of discoveries ushered in the modern scientific era. Between 1859 and 1895, Darwin's Origin of Species saw publication, Dmitry Mendeleyev organized the elements into a periodic table that showed their relationships and hinted at the existence of an atomic structure and Joseph Lister

performed the first antiseptic surgery. From 1895 to 1912, a series of extraordinary scientific finds and theoretical breakthroughs would suddenly turn the world of physics topsy-turvy and thrust a new, modern scientific era upon the world. At the same time, these discoveries would place more power, both constructive and lethal, than ever before in the hands of human beings.

This task focuses on the beginning of the twentieth century (1885-1925) and on understanding the concepts of radiation and radioactivity. Beginning in the late 1800's, this period marks a time when most people believed that magic of modern life would continue forever. The discovery of radiation started a series of experiments around the world that would eventually lead to the basis for nuclear weapons. As scientists began to unravel the mysteries of the atom, they began to see the potential of their knowledge. But the good time of the early years, promising peace, prosperity, and pleasant living, were fraught with problems caused by industrialization and urbanization.

Your task is to compare and contrast the endeavors of science and technology during the late 19th century to the early years of the 20th century.

You must examine events that established the corner stones of nuclear science and nuclear technology. Scrutinize these events in the context of the time periods. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the "Era of Hope and Promise" in science and technology.

This task focuses on the Era of Hope and Promise in Science, 1885 to 1925. This period marks the discovery of radiation and the beginning of our understanding of nuclear science. Scientific knowledge and technological advances virtually created the positive, wild spirit of the industrial era. Using this as a reference point, address the following in relation to the time period:

1. Compare how science and technology have evolved in the period between 1885 and 1925 with that of previous time periods? How does it differ from the evolution of science and technology during previous time periods?
2. Describe the relationship between scientific development and technological development (cite examples) during this time period.
3. Politically and economically, the western world was progressively moving toward equality between men and women. How did the political and social environments of the day (cite examples) impact the pursuit of science?

4. How did the nationalism movement interpret and use the advances made by science and technology? Discuss the differing views toward the growth of science and technology in the new nationalistic visions.
 5. Outline how the field of physics moved into a period of great vitality, excitement and confusion during the early years of the twentieth century, the beginning of modern physics. Begin with Roentgens discovery of the X-ray. Explain why many people became concerned about the end of their personal privacy with the discovery and use of X-rays.
 6. Politically and economically, the western world was entering a time of turmoil in the late nineteenth century and early twentieth century. How did the political and social environments of the day (cite examples) impact the pursuit of science?
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Suggested Classroom Activities for Task #3

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the time period called the "Era of Hope and Promise", from 1865 AD to 1925 AD. Using this as reference points, address the following in relation to the time period:

- 1.** Have students identify technological advances based on the science discoveries of the late 19th and early 20th century. Develop a chart showing the new technology and the science behind it.
 - 2.** Identify nationalistic movements in Europe and the United States that would impact the scientific endeavor. Describe the different impacts.
 - 3.** Have students research how E. Goldstein discovered the positively charged sub-atomic particle and John Thomson discovered the electron. (Excuse me... how can you discover a particle so small that nobody has ever seen one?)
 - 4.** Develop a historical timeline for the discovery of the atom.
 - 5.** Have students build models of various atoms and describe how they may combine to build molecules.
 - 6.** What is radioactivity? How does it differ from radiation? How do radioactive properties of an atom compare with the atoms chemical properties?
 - 7.** Identify and describe the different kinds of radiation. List some health effects of these common radiation's. What is the difference between ionizing and non-ionizing radiation. List uses for both ionizing and non-ionizing radiation.
 - 8.** Research and develop a short play on the discovery of radon and eventual health hazards that were encountered.
 - 9.** Have students research and discuss radioactive decay. How does this relate to the organization of the periodic table?
 - 10.** Complete the personal Radiation Survey [attached]. Design and conduct a radiation interview to discover what others believe.
 - 11.** Complete the table for the half-lives of significant radioisotopes listed [attached].
-

Task #4 – Splitting the Atom

"When I really understand something, it is as if I had discovered it myself."

-Richard Feynman

Fueled with the exciting discoveries of radioactivity, quantum theory and relativity, the first 25 or 30 years of the twentieth century witnessed an enormous fertility of ideas and discoveries unparalleled in the history of physics. A dynamic cluster of men and women - ambitious, brilliant, keenly prepared and talented - gathered in the universities of Europe, Britain and, to a lesser degree, Canada and the United States to ride the crest of a great wave of exploration into the inner regions of the atom.

This task area focuses on the events leading up to the development of the atomic bomb (1900-1939). Beginning in 1913, Niels Bohr modified the concept of electron orbits in the atom which led to his acclaim as the Father of Atomic Theory. Of course, Bohr's model of the atom is by no means the last word. Our ideas about the atom have changed a great deal since his announcement in 1913. The discoveries following Bohr would eventually lead to the splitting of the atom. As scientists continued their work splitting lighter elements, no one at the time thought that it was possible to split a uranium atom.

Your task is to discover and understand the implications of the scientific endeavors during the early years of the 20th century and the drivers that would lead to the Second World War.

You must examine events that further established the corner stones of nuclear science and nuclear technology. Scrutinize these events in the context of the time period. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the events leading to "Splitting the Atom."

This task focuses on scientific discoveries during the early 20th century that led to scientists splitting the uranium atom. This period marks new discoveries and understanding of nuclear science. Scientific knowledge and technological advances virtually created a wild spirit leading to the nuclear age. Using this as a reference point, address the following in relation to the time period:

1. Beginning with Ernest Rutherford, outline the contributions of the following scientists in understanding the composition of the atom.

- Ernest Rutherford

- James Chadwick
- Ernest Lawrence
- John Douglas Cockroft & Ernest Thomas Sinton Walton

2. Trace the events that led to the beginning of the Manhattan Project starting with the realization in 1938 by Austrian physicists Lise Meitner and Otto Frisch that German chemists, Otto Hahn and Fritz Strassmann, had done the undoable. They had split the uranium atom. What political significance could such a scientific discovery have that would push the United States to the development of the atomic bomb?

3. Describe the political, social and economic environments that existed during the time period after World War I. Consider the scientific discoveries being made and how different political entities might have viewed them.



Suggested Classroom Activities for Task #4

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the time period from 1900 to 1939. Using this as reference points, address the following in relation to the time period:

- 1.** Have students identify technological advances based on the science discoveries of the early 20th century. Develop a chart showing the new technology and the science behind it.
 - 2.** Identify nationalistic movements in Europe and the United States that would impact the scientific endeavor. Describe the different impacts.
 - 3.** Have students research the German and Japanese scientific efforts of this time period.
 - 4.** Develop a historical timeline for the splitting of the atom.
 - 5.** Have students build models of the various atoms in the Uranium-238 decay chain and describe how the radioactively decay scheme.
 - 6.** Have students research and discuss the implications of the following scientific discoveries:
 - Mendeleev's "Correlation Between Properties of Elements and Their Atomic Weights"
 - Rutherford and Soddy's "Theory of Radioactive Disintegration"
 - Thomson's "Plum Pudding Model"
 - Planck's "Quantum Theory of Heat"
 - Schrödinger's "Wave Mechanics"
 - Aston's "Mass Spectrograph"
 - Joliot and Curie's "artificial radioactivity"
-

Task #5 – The Manhattan Project

"Now I am become death, a destroyer of worlds."

-J. Robert Oppenheimer, 1945
(quoting the Bhagavad Gita)

With the news that German scientists had achieved nuclear fission, consternation mounted in the United States about the possibility that Adolf Hitler might succeed in developing an atomic bomb. For such a weapon to fall into the hands of such an unprincipled leader in the midst of a war was unthinkable. In 1939 Leo Szilard persuaded Albert Einstein to convince U.S. president Franklin D. Roosevelt that the United States urgently needed to begin a crash program to develop a fission weapon. Einstein, a known pacifist, reluctantly backed such a project because Hitler and the Nazis had become the single most heinous force ever to gain power in the world. Thus the Manhattan Project was born.

This task area focuses on the events during the development of the atomic bomb and the time immediately following (1939 -1950). Beginning in 1939, the knowledge that uranium could be split and release tremendous amounts of energy, for an atom, set in motion a huge endeavor to discover ways to produce huge amounts of energy from the atom. This would necessitate a chain reaction if a bomb was to be developed. Following the war, the thought that such a weapon could be developed by other nations gave rise to the policy of deterrence thus leading to the Cold War.

Your task is to discover and understand the implications of the scientific and technological breakthroughs made during the years of the Manhattan Project and the drivers that led scientists and government leaders to develop the atomic bomb during the Second World War.

You must examine events that took place throughout the world as scientists rushed to further their understanding of nuclear science and nuclear technology. Scrutinize these events in the context of the time period. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the events leading to the "development of the Atomic Bomb."

This task focuses on scientific discoveries during the mid-20th century that led to scientists developing and testing the atomic bomb. This period marks new discoveries and understanding of nuclear science. Scientific knowledge and technological advances

virtually created a world split between euphoria and fear giving rise to the thought that such a weapon could be developed by other nations thus the development of the policy of deterrence which lead to the Cold War. Using this as a reference point, address the following in relation to the time period:

- 1.** Describe the political environment which created Second World War drove world renowned scientists toward the development of an atomic bomb.
- 2.** What were the scientific contributions from the following? What were the political drivers behind each?
 7. Enrico Fermi
 8. J. Robert Oppenheimer
 9. Edward Teller
 10. George Eltenton
 11. Klaus Fuchs
 12. Werner Heisenberg
 13. Robert Krohn
 14. Edward McMillan
 15. Frank Oppenheimer
 16. Isidor I. Rabi
 17. Robert Serber
 18. Stanislaw Ulam
 19. Robert Wilson
- 3.** Describe the relationship of the different fields (mathematics, physics, chemistry, engineering) needed for the development of the atomic bomb. Why do you think biology was left off this list?
- 4.** When the first atomic bomb was detonated over the desert of south central New Mexico, many of the scientists were ecstatic. The success represented , as one scientist said, "the best years of their lives" and J. Robert Oppenheimer was quoted, "Now I am become death, a destroyer of worlds.". Explain what these two quotes meant.
- 5.** On July 26, 1945, U.S. president Harry S. Truman released a document known as the Potsdam Declaration. Its transmission was received by Japan on July 27. What was the significance of this declaration and the eventual detonation of the two atomic bombs on Japan?
- 6.** When asked toward the end of his life what he thought of recent efforts toward nuclear arms control (mid 1960s), J. Robert Oppenheimer said, "It is twenty years too late. It should have been done the day after Trinity". Why did he, the father of the atomic bomb, feel this way? Explain why early talks would have/not have prevented the Cold War and eventual arms race?

7. If the United States and its allies had not developed the atomic bomb, what do think the eventuality of its development would have been? What do you think was the greatest legacy of the "bomb" in the years immediately following the end of World War II?

Suggested Classroom Activities for Task #5

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the time period from 1939 to 1950. Using this as reference points, address the following in relation to the time period:

- 1.** Have students compare and contrast the economic conditions leading up to World War I and World War II.
 - 2.** Assign the roles of Stalin, Churchill, and Truman to three students. Have the class research and prepare a text of the discussion between the three men at Potsdam. Discuss why the agreements made, at Potsdam were doomed to fail.
 - 3.** Hold a mock presidential cabinet meeting where President Truman discusses whether to share the secrets of the bomb with U.S. allies.
 - 4.** Research scientific activities that took place in Los Alamos during the Manhattan Project. Discuss the feelings that different scientists had during this time and immediately following the detonation of the test bomb.
 - 5.** Develop a media release to the public informing them of the successful test detonation of the first atomic bomb. Develop this release from two different perspectives, the media of the time and the media of today.
 - 6.** Develop and discuss possible scenarios that might have occurred if the U.S. had released atomic secrets at the end of the Second World War.
-

Task #6 – Beginning to End of the Nuclear Cold War

"If we fight a war and win it with H-bombs, what history will remember is not the ideals we were fighting for but the methods we used to accomplish them. These methods will be compared to the warfare of Genghis Khan who ruthlessly killed every last inhabitant of Persia."

-Hans A. Bethe.

The year 1945, a bitter and jubilant time marked the end of a terrible war - a world war that saw the annihilation of millions of Jewish people, the destruction of much of Europe, the unhinging of large parts of Asia and the Pacific, the decimation of two cities of Japan and the death of millions of other soldiers and civilians. At last, with great relief, the world could get back to the business of living. And scientists could get back to doing science.

The end of the Second World War brought peace and prosperity to the United States, but the political ambience was not as peaceful. The world psyche after World War II was deeply shaken and the world could not escape the new anxieties created by the existence of the atomic bomb. Aggressive foreign policies led to an arms race and a new kind of conflict, the Cold War, began almost immediately. Using these as reference points, address the following:

"You say you want a revolution. Well, you know, We all want to change the world."

-John Lennon

By 1945, exploration of the new world within the atom had only just begun. Today some 200 subatomic particles are known, and more are believed to exist. The story of their discovery has been an intricate and intriguing whodunit that has absorbed some of the best minds of the century.

Today, there are as many scientists currently at work in the world as have existed in the entire history of science. Hundreds of specialties from computer science to microbiology and from astrophysics to particle physics attract young people who have a thirst for knowledge. Science provides us all, whether we are professional scientists or not, with a special window on the world that enables us to see in ways we might not otherwise see and understand in ways we would not otherwise understand. It is a special, and uniquely human, way of thinking. The end of the Cold War, the tearing down of the Berlin Wall and the development of computer aided global communications are some of the events

that are shaping the new history of today. The world around us is constantly changing, and with increases in technology, these changes seem to be occurring at a geometric pace. The ongoing revolution in science and technology is beset with political, social, economic and historical ramifications.

This task area focuses on the latter half of the twentieth century, from 1945 to the present, on the events culminating with the end of the Cold War and the beginning of International collaboration. In the latter half of the century, science is viewed as both hero and villain. Blamed for the loss of the simple, natural life, science has given us the conveniences of the modern, complex life; from electricity to compact discs, automobiles and airplanes to space exploration, from satellite communication to fax machines, computers, and e-mail. And the cycle continues: discovery-spawning technology, which in turn leads to new discoveries leap frogging into the future. It is at this point that we find ourselves today.

Your task is to discover and understand the implications of the scientific and technological breakthroughs made after the Manhattan Project and the drivers that led scientists and government leaders to develop and test more powerful bombs.

You must examine events that took place throughout the world as scientists rushed to further their understanding of nuclear science and nuclear technology. Scrutinize these events in the context of the time period. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the events leading to "nuclear arms escalation." and the strained relations between global powers.

This task focuses on scientific discoveries during the latter part of the 20th century that led to scientists developing and testing the hydrogen bomb. This period marks new discoveries and understanding of nuclear science. Scientific knowledge and technological advances virtually created a world split gripped with fear giving rise to the nuclear arms race, the policy of deterrence, and competition in space exploration. Using this as a reference point, address the following in relation to the time period:

1. Compare and contrast the Cold War from the perspectives of the "West" and the "East". Explain why the Cold War was a scientific war as well as a political war.
2. Information about radiation, nuclear materials, and nuclear testing results were considered top secret and vital to national security during the Cold War. What were the effects of this secrecy on the public? How did the public learn about nuclear things

during the 1950's? How did you learn about nuclear things and what are your feelings toward them?

3. Fear of nuclear weapons is justifiable. What are your thoughts on other uses of nuclear material? What was the probability for completely eliminating nuclear materials from our world during the Cold War? What were the views on managing nuclear materials for the good of human kind during this period of time?

4. In the early 1970s, the U.S. Department of Defense began a network of military computers dubbed ARPAnet (Advanced Research Projects Agency network). This effort turned out to be the forerunner of today's Internet. Describe the use of the Internet today as an information source. How has the Internet affected society? How has it affected education and the art of studying?

5. The end of the Cold War sees the world entering a new phase. What are the impacts, positive and negative, that exist as a result of the Legacy of the Cold War Period? Include an assessment of risk, public attitudes and concerns.

"As similar as human beings are in many ways to other species, we are unique among the earth's life forms in our ability to use language and thoughts.

We are also unique in our profound curiosity about ourselves."

-From Science for All Americans

Suggested Classroom Activities for Task #6

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the time period from 1945 to the present. Using this as reference points, address the following in relation to the time period:

1. Research the period known as "The Cold War". Develop a comparison chart with heading for scientific endeavors and for political endeavors.
2. During the Cold War period, scientists from different fields (mathematics, physics, chemistry, engineering, biology, etc.) were recruited for the newly emerging national laboratories. Develop a chart showing the emphasis of their research and any spin offs of their research that benefited society.
3. Discuss the political ramifications of the launch of "Spudnik"/ Discuss how it affected the direction of scientific research and the effect it had on education in the United States?
4. John Fitzgerald Kennedy once said, "We seek not the world-wide victory of one nation or system but a world-wide victory of man. The modern globe is too small, its weapons too destructive, and its disorders too contagious to permit any other kind of victory." Given the political and economic conditions during the years that followed the Second World War, debate the likelihood that his vision would come to fruition and the likelihood that the world can achieve this goal in today's political and economic environments?
5. Research all uses of nuclear material? Discuss the probability for completely eliminating nuclear materials from our world.
6. Discuss how the Freedom of Information Act, which made available information that for long had been classified and kept away from public dissemination, has this impacted the scientific endeavor? Discuss the effect it has had on the political and social worlds?
7. Trace the history of the Internet, and discuss the use of the Internet today.
8. Compare the directions of scientific research during the "Cold War" period and the present.
9. Discuss how other countries view issues focusing on monitoring of materials, developing organizations and signing treaties to deal effectively with "things nuclear" compared with the United States position.
10. Develop a survey to administer to community members of all ages in order to gauge the awareness of the public on the issues and areas you have studied this semester. Compile and interpret the survey results Discuss the implications of the results.

Terrorism in a Nuclear Age

Introduction

"Spurred by modernization, global politics are being reconfigured along cultural lines. Peoples and countries with similar cultures are coming together. Peoples and countries with different cultures are coming apart. Alignments defined by ideology and superpower relations are giving way to alignments defined by culture and civilization. Political boundaries are increasingly redrawn to coincide with cultural ones: ethnic, religious, and civilizational. Cultural communities are replacing Cold War blocs, and the fault lines between civilizations are becoming the central lines of conflict in global politics."

-from *The Clash of Civilizations and the Remaking of World Order*

The topic of terrorism focuses on our nation's ability to monitor and counter terrorism, nuclear, biological, and chemical terrorism, and will involve students and teachers in examining this matter of international importance.

What effect does the word "terrorism" have on citizens of the United States? How much do we really know about terrorist activities? Can terrorism be controlled? What are possible solutions for abating terrorist activities? Does might make right? What part does history play in the equation of today's terrorist activities? Who are the terrorists of today? What are their motives? What role does science (economics, social position, education, politics) play in causing or abating terrorist activities?

In 1972, terror exposed its ugly head at the Olympics. A group of terrorists held the Israeli Olympic delegation hostage for a number of days. After many years of efforts to dissuade terrorism, similar activities still occur. What motivates individuals and factions to engage in activities that are outside normal lawful endeavors? What drives these individuals? Are they the only terrorists, or is this only from a singular perspective? These questions need to be examined if we are to resolve the terrorist problem.

Imagine a picture of a Russian worker carrying missile cone heads removed from a former Russian nuclear missile. Imagine the ease of transferring these nuclear weapon missile cone heads to the "Black Market". Then imagine the possible movement of nuclear materials to rogue nations through the same black market.

Present solutions to the problem have been to attack might with might. Police and military personnel have been trained in anti-terrorist tactics and have led the effort to eradicate the problem. But the problem still exists. Do we need to increase our efforts or look at other alternatives? Students and teachers involved in the Critical Issues Forum will consider such questions. Our future depends on resolving this issue. We must examine all facets of the problem and reach consensus, not only with ourselves, but with those factions considered terrorists.

We must not let the unthinkable occur. We must strive to make the world a safer place to live.



Task Assignments for Terrorism in a Nuclear Age

Task #1 – Foundations of Terrorism

"There will always be disaffected, alienated and highly aggressive people claiming that the present state of affairs is intolerable and that only violence will bring about a change."

... Walter Laqueur

In the dead of night, a group of disguised insurgents, destroy a large quantity of a valued cash crop. Their actions bring about retaliation from the regions governing body.

In an isolated mountain village, a group of armed insurgents take over a government facility in an effort to reclaim what they believe to be their natural birth rights. Ensuing efforts to dislodge them involve coordinated efforts of several police and military agencies.

On a warm summer evening, a group of armed insurgents infiltrate the living quarters of several young athletes at a large, international sporting event. Several athletes are killed while numerous others are held captive for many days.

*"You, created only a little lower than
The angels, have crouched too long in
The Bruising darkness....
Do not be wedded forever
To fear, yoked eternally
To brutishness."*

..... Maya Angelou

To help us gain an understanding of why people engage in terrorist activities, we must gain an insight to perspectives from those who commit terrorism and from those who are victims of terrorism. This section focuses on the foundations of terrorism, what terrorism is, how it has manifested itself throughout history and how the four domains (science, economics, politics, and social/cultural) are impacted.

Your task is to consider issues surrounding the foundations of terrorism, collect appropriate data, and report on your findings and conclusions.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus

of these tasks is comparing acts of violence and terrorism during different periods of history. You are to research, gather data, and thoroughly demonstrate your understanding of the foundations of terrorism.

1. Differentiate between race, ethnicity, and nationalism. Include scientific basis and misperceptions seen in each. Consider the interactions between science, politics, and culture.
 2. Identify and describe an act of terrorism that took place during the following time periods. Include the role that technology played in each act.
 - pre- 1 AD
 - 1 AD to 1000 AD
 - 1000 AD to 1500 AD
 - 1500 AD to 1900 AD
 - 1900 AD to 1950 AD
 - 1950 AD to 1980 AD
 - 1980 AD to Present
 3. Describe the similarities and differences of war, organized crime, street violence, and terrorism.
 4. Select an act of terrorism and from opposing perspectives develop a short paper in which you rationalize the act as having positive and/or negative consequences. Include perspectives in regard to race, ethnicity, nationalism, and appropriate scientific explanations.
-

Suggested Classroom Activities for Task #1

- 1.** A Terrorist Event: Arrange a dramatic exercise in which the class is "held hostage" by a "terrorist". Explore the feelings of the terrorist: his/her affiliations, methods, and goals. Examine how the class members feel about being held prisoner.
 - Present a group of disguised past events (like the Boston Tea Party) on description cards and decide which ones are and are not terrorist acts. Use this as the basis of a brainstorming session to define terrorism.
 - 2.** Print out copy of BM#1 Questions and Tasks. Have students brainstorm what each question is seeking. Break up group to address each identified task in question #1, then #2, and so on. When each group has completed their task, have them share the information they discovered and build a matrix for each question that will allow them to begin seeing connections.
 - 3.** Socratic dialogue between group members (teacher facilitated) on what they see as differences between race, ethnicity, and nationalism. As the discussion progresses, introduce the elements of science, politics, and culture. Have a student/s act as recorder/s.
 - 4.** View short clips from movies depicting specific examples of (1) war, (2) organized crime, (3) street violence, and (4) terrorism. Have students brainstorm what they see as outcomes, goals and objectives of the four areas. Lead students in a discussion of what they see in the movie clips in regard to the above.
 - 5.** Create a large world reference map showing where major examples of terrorism have occurred throughout history. An accompanying timeline might also be helpful.
 - 6.** Develop a newspaper page with articles about past acts of terrorism written by students. Use these articles when completing the assigned paper.
 - 7.** Have a group project where each group constructs a collage showing war, criminal acts, street violence and terrorism. Students could also do role playing depicting examples of each. Have students describe the collage and role playing as their assigned paper.
 - 8.** A culminating activity could be a mock trial of an accused terrorist from one of the introductory scenarios. Have students incorporate the elements of the assigned task. Record and prepare a transcript of the trial to meet the requirements for question #4.
-

Task #2 – Types and Methods of Terrorism

"This is a new kind of war, new in its intensity, ancient in its origin...war by guerillas, subversives, insurgents, assassins; war by ambush instead of combat, by infiltration instead of aggression, seeking victory by exhausting the enemy instead of engaging him."

..... John F. Kennedy

"Tradition is a wellspring of human life. From it issues forth sentiments, beliefs, customs, mores, and norms that are handed down by speech, writing or other sufficient signs from generation to generation. Long-established ways of thinking and/or acting ground tradition, which shapes the contours of conscious and unconscious, as well as rational and irrational behavior. It is also shaped by these behaviors. In tradition inhere the best and the worst of the thought and conduct of Homo sapiens sapiens. Through it, guideposts of acceptability and the pathways of permissibility are made known, whereby individuals are inclined to behave in ways that make them better or worse, when judged against standards of human decency."

.....Winston A. Van Horne (Global Convulsions, 1997)

On the morning of April 19, 1995 an explosion at the Alfred P. Murrah Federal Building in Oklahoma City killed 168 people and injured hundreds of others. This is just one of many such incidences which have altered how we view terrorism.

"Passionate hatred can give meaning and purpose to an empty life."

..... Eric Hoffer

Your team has been assigned to investigate a recent incident which took place at an office complex in Chicago. The building houses the following organizations:

- the Internal Revenue Service (IRS),
- the Tourism Bureau for Great Britain,
- the Tourism Bureau for Japan,
- a furrier,
- B'nai Brith,
- Globotech, a worldwide global technology conglomerate,
- the World Bank regional office,
- Planned Parenthood,
- the Socialist Workers Party.

Three canisters containing noxious/toxic substances had been planted at sites around the complex. They were set to release their contents at thirty- minute intervals beginning at 9:00 am. The first release killed two and hospitalized seventeen who were treated for respiratory distress, nausea, and itching, burning eyes and skin. The second release took place as firefighters and paramedics were evacuating the building, sending twelve more people to the hospital with similar symptoms. The final device was recovered and safely destroyed by the Haz-Mat Team. No person or organization has claimed responsibility for this act; however, it is assumed to be an act of biological and/or chemical terrorism.

To help us understand the types of and methods used for terrorist attacks, we must begin to investigate the various terrorist groups around the world and learn about the different approaches to their activities. This section focuses on the various types of activities used by terrorists. You will investigate a number of known terrorist groups and how the four domains (science, economics, politics, and social/cultural) impact their decisions and behaviors.

Your task is to consider issues surrounding the types and methods of terrorism, to collect appropriate data, and report on your findings and conclusions. You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing types and methods of terrorism at the international, national, and regional arenas.

Complete both tasks.

Task 2a - Your mission is to investigate and submit an initial report on the Chicago incident. Your supervisor requires the following from your analysis:

1. Describe what happened including an overview of chemical and biological weapons that may have been used in this attack.
2. Create a database composed of suspect terrorist groups including all relevant information available about these groups. Include a short paper in which you describe your database and explain why you included the information you did.
3. Develop a map showing relevant geographical information about these suspect groups. Submit a graphic (3in X 5in max) of your map and a description of its components.
4. Develop a short paper in which you categorize the suspect groups in as many ways as are appropriate to this investigation. Be sure to include the impact on the four domains (science, economics, politics, social/cultural).

Task 2b –

"If one man offers you democracy and another offers you a bag of grain, at what stage of starvation will you prefer the grain to a vote?"

.....Bertrand Russell

Select and complete one of the following:

1. You are a guard at a former top secret research facility which stores all types of materials and weapons. You have not been paid for five months and have a wife and family to support. A known terrorist approaches you with cash in hand....wanting a list of materials you might have available. Write a short "reflective" paper including the following:

- Describe the psychological pressures existing in your life.
- What moral and ethical questions might you be faced with? What are your thoughts on each?
- You have two choices, you prepare the list or you do not prepare the list. What specific elements must you consider with either decision?

2. You are a terrorist group applying for funding from an underground, international terrorist funding foundation. You must produce a grant proposal for consideration. Be sure to include your group goals, targets, justifications, weapons, methods, a budget, expected outcomes and mission goals, the economic impact on your target, and the social/political ramifications.

3. You have just been sworn in as an FBI agent. You have been assigned to the anti-terrorism unit. How will you uphold the rights of the citizens as specified in the Constitution of the United States while developing a scheme for protecting the citizens of the United States. Develop a new anti-terrorism handbook, a short paper, in which you include the following:

- description of how domestic terrorism relates to hate crimes,
- description of current and future methods of prevention that may be used,
- description of forensic improvements (such as tagging) for investigative purposes which can be implemented now,
- description of capabilities existing within terrorists groups for accessing information,
- description of areas with high vulnerability for domestic terrorist activity.



Suggested Classroom Activities for Task #2

- 1.** Invite a speaker to come to your class. The speaker could be from any number of organizations such as the FBI, your local police or fire department, active military personnel, etc.. Try to discuss all side of the issues focusing on types and methods of terrorism.
- 2.** Role play a terrorist takeover on an airplane. Have students consider what the passengers should do, what the pilot and crew should do relative to the threats provided by the terrorist. What measures might be taken for a rescue attempt?
- 3.** Arrange a panel discussion including a emergency response team member, an emergency medical professional, and an area hospital representative. Questions could involve local capabilities to respond to biological, chemical, and nuclear attacks.
- 4.** Using a forensic scenario - Prepare a forensic packet of evidence so students can "solve" the Chicago incident presented in Task #2. (SueAnn Dobbyn of San Andres High School has prepared a packet and could send it to other interested groups. Contact her at sadobbyn@zianet.com)

Here's the game plan for the use of the forensic materials with Task #2:

First, we want them to be mostly done with the database and survey of CB weapons before they use this file. At this point the students will be given the paper file and the physical evidence. The paper file is sufficient to determine a chemical agent used and suggest a perpetrator if they analyze it. To determine who actually planted the device, the students need to lift the fingerprints off the plastic remnant of the device and off the sales receipt for the timers. To do this they only need to use simple forensic techniques.

- 1) To lift the print off the plastic you sprinkle carbon black on the area then carefully blow off the excess. Use wide scotch tape to lift the print off the surface and apply it to an index card.
- 2) The print on the sales receipt can be made visible by either of two techniques. One: place the receipt in a jar which has about a teaspoon of iodine crystals in the bottom. The receipt should be suspended in the jar by taping it to the lid. The print should become visible in about 15 minutes. ID should be done immediately since the print will fade (unless you "fix" it in a solution of 12.5g calcium chloride and 4.4g potassium bromide in 100ml water). The other way is to put the receipt in a solution of 1.6g ninhydrin dissolved in 30ml acetone. Then you take it out and let it dry. The print will be visible within 24 hours.

Anyone who wants to use these materials can just e-mail Sue Ann Dobbyn if they want a set of "physical evidence". They really can't make these up themselves because the perps fingerprints won't match the file prints they have unless I do it for them. But I'd be happy to do so and send it in the mail as fast as possible.

5. Brainstorm, capture and categorize issues you feel would be relevant to a terrorist group deciding on a target, the methods to be used, and the types of activities to be carried out. What goals are to be reached? What methods would be best to accomplish these goals?
6. Investigate the history of the use of different types of terror campaigns. What seems to be a common or preferred method used by terrorists throughout time?



Task #3 – Motivation and Making Sense of Terrorism

Visualize an image of a slum area, church in background, with an official diplomatic limo driving through. Terrorist acts have been used throughout history at many levels to achieve various goals. Individual perspectives, cultural diversity, and environmental conditions contribute to the desire for change in adverse conditions.

"Tradition is a wellspring of human life. From it issues forth sentiments, beliefs, customs, mores, and norms that are handed down by speech, writing or other sufficient signs from generation to generation. Long-established ways of thinking and/or acting ground tradition, which shapes the contours of conscious and unconscious, as well as rational and irrational behavior. It is also shaped by these behaviors. In tradition inhere the best and the worst of the thought and conduct of Homo sapiens sapiens. Through it, guideposts of acceptability and the pathways of permissibility are made known, whereby individuals are inclined to behave in ways that make them better or worse, when judged against standards of human decency."

.....Winston A. Van Horne (Global Convulsions, 1997)

As the threat of Nuclear, Biological and Chemical terrorism increases throughout the world, we must consider the causes underlying terrorist activities and the perspectives of people within other countries. We must determine what drives these terrorist actions as we develop means to counter terrorist activities. We must continue to develop and refine the diplomatic means to accommodate our differences.

Not only must we determine what political, economic, social, cultural and historic dynamics exist between major countries and how these dynamics contribute to the perspectives of young people living in those countries today, we must also look at ourselves, our local and regional communities, and determine the same dynamics.

"There are two statements about human beings that are true: that all human beings are alike, and that all are different. On these two facts all human wisdom is founded."

.....Mark Van Doren

To help us understand the motivations and make sense of terrorist attacks, we must begin to investigate the various terrorist groups around the world and learn about the philosophies that guide them in their quest. This section focuses on motivations leading

to terrorist attacks. You will investigate a number of know terrorist groups and how the four domains (science, economics, politics, and social/cultural) impact their behavior.

"Whatever touches the nerves of motive, whatever shifts man's moral position, is mightier than steam, or calorie, or lightening."

..... Edwin Hubble Chapin

Your task is to consider issues that provide motivation for disenchanted groups or individuals to pursue drastic means they feel will resolve these issues, to collect appropriate data, and report on your findings and conclusions.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing acts of violence and terrorism at the international, national, regional and local arenas.

- 1.** Discuss the effect that the availability of resources has on one's motivation to take some kind of action, legal or illegal. Include your thoughts on whether or not equalization of power effects motivation for committing terrorist activities.
- 2.** Describe the possible actions and motivations for improving the conditions necessary to alter the future of those involved in acts of terrorism.
- 3.** Compare and contrast events commonly referred to as terrorist activities with violent events on a regional and local community level.



Suggested Classroom Activities for Task #3

1. Read the five CNN headlines below.

- Unionists reject proposals for Irish peace talks.(July 23, 1997)
- Israeli Arab man injures 11 tourists in Tel Aviv attack. (July 23, 1997)
- Eight militants killed in Kashmire, blast injures 12 on highway. (July 24, 1997)
- Iraq rebuffs U.N. decision on oil-for-food. (December 5, 1997)
- Former KKK member allegedly vowed to burn church again. (August 20, 1996)

Write a brief description of what you would expect in the story to follow each headline. What assumptions did you make and what were they based on? Describe what you felt when you read each headline.

2. Describe what you think is the driving force behind these kinds of actions in our world today? What evidence supports your thoughts?

3. If you lived in an environment as depicted in the picture on the previous page (Task #3 Introduction), suggest ways to alter your future in such a way as to improve your quality of life.

4. Through dialogue groups, students should establish goals for creating a set of matrices as a culminating activity for Tasks 1-3. They should determine possible questions and considerations to include all aspects of terrorism and development of an informational matrix. Students should establish the parameters for the matrix to include Tasks 1-3 and the four domains. Each team should prepare the following.

- their team portfolio of Tasks 1-3 work
- research and chronicle articles of terrorist activities (historical and current)
 1. newspaper,
 2. magazines,
 3. anecdotal reports,
 4. interviews, etc.
- Students should brainstorm 3-5 possible terrorist activities at the regional community level. They should develop a matrix to detail each terrorist activity.
- Students should brainstorm 3-5 possible terrorist activities at the local community level. They should develop a matrix to detail each terrorist activity.



Task #4 – The Media and Terrorism

On Halloween Eve, October 30, 1938, a radio program of H.G. Wells' "War of the Worlds" was broadcasted by Orson Wells. The format of the broadcast was a news report of an invasion of the United States by Martians. The show unexpectedly created enormous panic when many people, having missed the initial disclaimer, believed that this "invasion" was actually occurring. This seminal event revealed the power of the media to influence human actions and opinions.

"Whoever controls the media - the images - controls the culture."

..... Claude Cockburn

The media can inform or misinform. Buyer beware.

To help us understand the role of the media and how this role has become a powerful entity in today's world; we must begin to investigate the different methods used to inform the public. We must also learn how the use of the media can be both positive and negative depending on who is controlling the message. This section focuses on the media, the rights of human beings to know, and how the media can be manipulated by either side. You will investigate the media in various countries and determine how the four domains (science, economics, politics, and social/cultural) impact decisions and behaviors of media personnel, government officials, the public, and terrorists.

Your task is to consider issues that surround the use of the media and its reporting of terrorist activities, to collect appropriate data, and report on your findings and conclusions.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing the role of the media at the international, national, regional and local arenas.

1. Compare and contrast the impact of the "War of the Worlds" as it would exist in each of the following time frames. Support your conclusions. Explain how your analysis would apply to terrorist-like events in the same time frames.

- ancient (pre-1600)
- the 1600's
- the 1880's
- the present

2. Choose a terrorist incident and create four media presentations (any format) based on each of the following perspectives:

- a media organization aligned with the US Government,
- a media organization aligned with the mainstream US culture,
- a media organization aligned with the terrorist group,
- an independent media organization trying to present a factual, fair, unbiased presentation.

3. Track the evolution of the media coverage of a recent, significant terrorist event from its appearance in the media to its disappearance. Delineate the ways in which the coverage changes over this period. Speculate on the reasons why these changes occur.

4. Describe the possible actions and motivations for improving the conditions necessary to alter the future of those involved in acts of terrorism. Create and describe a fringe group which incorporates terrorist acts as well as more acceptable and positive approaches to promote its own agenda.



Suggested Classroom Activities for Task #4

1. Probably the best known work of science fiction that made its way to radio in the thirties was Orson Welles' Mercury Theatre production of War of the Worlds broadcast on Halloween, 1938. Adapted by Howard Koch (Casablanca), the radio play, called "Invasion From Mars," bordered more on horror than escapist science fiction. Welles' recreation of H.G. Wells' story, "The War of the Worlds", was about the real world, his reflection on what was occurring in Europe at the time but told in future tense. By taking something fantastic and placing it into a world already on edge from depression and fear of war, Welles conjured up even more horrific images in the minds of his listeners. Visit the following Internet sites to learn more about Orson Wells' 1938 recreation of H.G. Wells' story, "War of the Worlds" originally published in 1898.

- <http://web2.airmail.net/lgroebe/waroftheworlds.htm> (script of the 1938 broadcast)
- <http://www.awod.com/war/links.html> (links to other sites dealing with the War of the Worlds broadcast)
- <http://www.otr.com/sf/html> (Real Audio format of first part of the 1938 broadcast)
- <http://www.fourmilab.ch/etexts/www/warworlds/warw.html> (electronic copy of H.G. Wells, "War of the Worlds" book)

Hold a class discussion on reactions you would expect in different time periods to the War of the Worlds storyline. What assumptions did you make and what were they based on? Discuss how you felt when you read the original text and the broadcast script. Discuss the differences between today, 1938, and 1898 that would have lead to different reactions. Think in terms of the four domains.

2. Describe what you think is a driving force behind the actions of the media in our world today? What evidence supports your thoughts?

3. Hold a class discussion on the effects different types of media have on individual student's attitude toward violence, the school community's attitude toward violence, individual perspectives toward other ethnic groups (be careful not to have a one sided conversation), a gang member's perspective on their local community, etc...

4. Have students identify 3-5 media accounts of terrorist activities at the regional community level and 3-5 accounts at the local community level. They should develop a matrix to detail the reporting of each terrorist activity and the reactions seen in their community.

Task #5 – Security and Monitoring

"There is no security on this earth, there is only opportunity. "

..... Douglas MacArthur

You are part of the advance team sent by the International Security Consulting Firm. Your job is to analyze the security needs of the Weapon At the Ready, Corporation facilities. After you have completed your analysis of the security needs of the firm, you will then prepare a proposal to provide those services.

Background information on the firm:

- Weapons At the Ready is an international weapons consortium,
- Weapons At the Ready is known for cutting edge technology,
- Weapons At the Ready is known for its diversity of products,
- Weapons At the Ready is known for its heavy commitment to extensive research and development programs,
- Weapons At the Ready is known to have a number of production plants located around the globe,
 1. Tokyo, Japan
 2. Cairo, Egypt
 3. Moscow, Russia
 4. Lima, Peru
 5. El Paso, Texas.
- Weapons At the Ready conducts its business via
 1. computer,
 2. fax,
 3. phone,
 4. person to person contact
- many of the Weapons At the Ready personnel make frequent trips abroad,
- internal security at Weapons At the Ready is of major concern.

Your task is to consider issues surrounding security measures for the movement, storage and monitoring of nuclear materials, to collect appropriate data, and report on your findings and conclusions.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus

of these tasks is comparing the role of the national security, scientific research, intellectual property and individual rights and responsibilities.

- 1.** Describe elements that should be incorporated into the design and development of a security plan for the Weapons At the Ready production plants (see previous page),
- 2.** Describe the methods that could be used to circumvent the security plan that is currently in place (make assumptions based on previous page as to the nature of the current security plan),
- 3.** An analysis of any correlation between increased security/monitoring and cost factors,
- 4.** An analysis of the socio-political environments in the 5 global production facility locations and the possible affect on your security plan.

Support your conclusions. Explain how your plan would counter terrorist-like events in future time frames.

Suggested Classroom Activities for Task #5

1. In light of the recent alleged security breaches at many of the national laboratories, the U.S. Congress has convened a number of hearings and meetings with top DOE and other government officials in regard to strengthening the security systems at the national research laboratories.

- Have students collect media records of these meetings and any decisions that were made
- Conduct a discussion on the investigative process as conducted by the FBI in regards to identifying and bringing a "spy" to trial
- Read and discuss the articles featured on the CNNFN Special Report page
- Read and discuss the following pages (chronological) on the Wen Ho Lee espionage investigation

2. Visit the following Internet sites to learn more about United States' nuclear policies.

- <http://www.nn.doe.gov/mpca/text/t-broch/t-inm97/t-inmm97.htm> (Partnership for Nuclear Security - United States/Former Soviet Union Program of Cooperation on Nuclear Material Protection, Control and Accounting)
- http://www.state.gov/www/regions/eap/980920_us-japan_jtstmt.html (Joint U.S.-Japan Statement: Security Consultative Committee)
- <http://www.la.utexas.edu/course-materials/government/mena/USME/su98/> (Issues and Policies In American Government: The United States and the Middle East)
- <http://www.security-policy.org/nuclear.html> (Center for Security Policy Publications)
- <http://nuclear-security.com/index.htm> (A Site for Information on Keeping US Nuclear Deterrence Strong)
- <http://www.fas.org/irp/eprint/snyder/proliferation.htm> (The Role of the United States Intelligence Community in Monitoring Nuclear Nonproliferation in the Post-Cold War Era)
- <http://www.clw.org/pub/clw/coalition/adv0127.htm> (Nuclear Security Issues in the State of the Union and the 1998 Senate)
- <http://www.nap.edu/readingroom/books/fun/1.html> (Why Change U.S. Nuclear Weapons Policy?)

3. Conduct a mock presidential cabinet meeting on issues surrounding theft of nuclear secrets and perceptions of need for higher security and monitoring of nuclear materials.

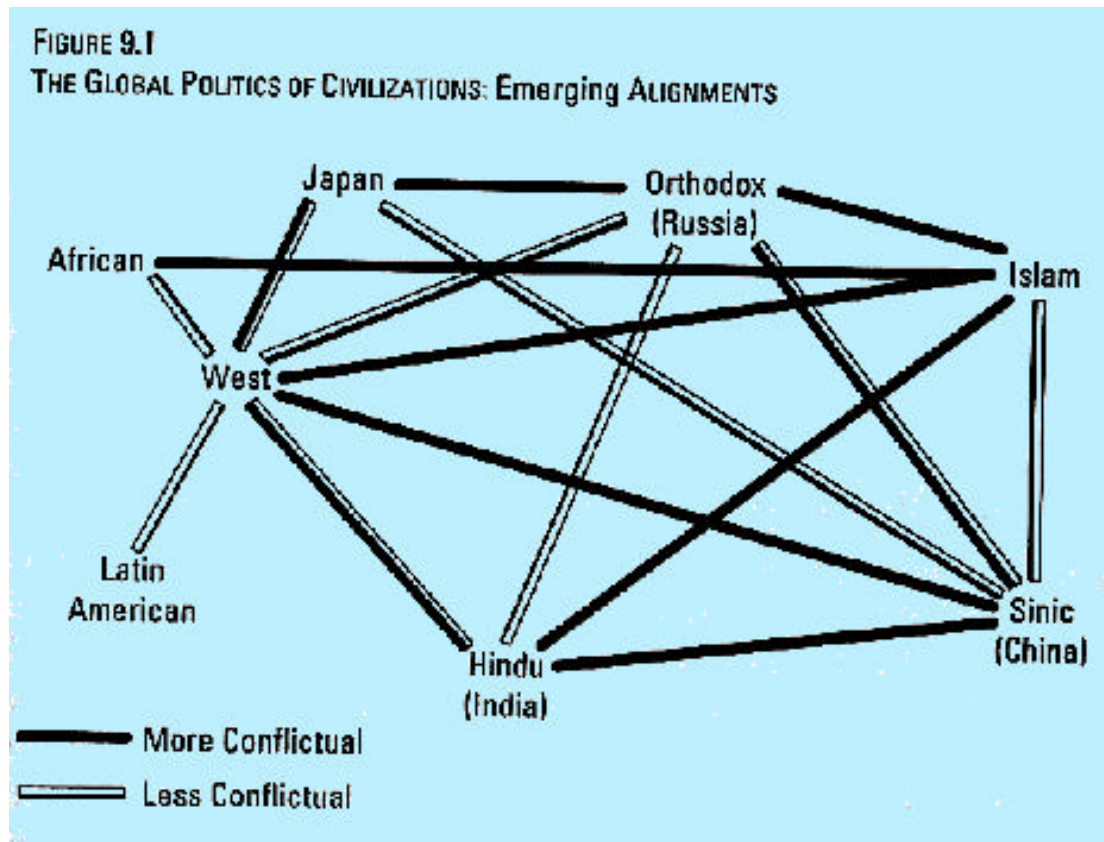
- Identify and assign a cabinet member role to each student.
- Have students research their assigned role and devise a descriptive profile of their character, how their character would react to the allegations and issues, how they would consider the impact of cabinet decisions on each of the four domains

(science, economic, political, social/cultural), and the position they will take in the debate at the meeting.

Task #6 – Future Outlook

"The social progress, order, security, and peace of each country are necessarily connected with the social progress, order, security, and peace of all countries."

..... Pope John XXIII



- from *The Clash of Civilizations and the Remaking of World Order*, pg. 245.

A new alignment of geo-political collaboration is emerging. Old barriers are deteriorating while new alliances are forming in the wake of the end of the Cold War. The graphic above depicts alignments now forming. How humans deal with war and terrorism will impact the multi-civilizational character of global politics and economics.

Your task is to consider issues surrounding the future of the nuclear world, policies, treaties, etc., to collect appropriate data, and report on your findings and conclusions.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus

of these tasks is comparing the terrorist activities from the past (pre-nuclear world), the present, and the future of the nuclear world.

(Consider this image of overpopulation -
Imagine people falling off the globe - View the
population numbers on the sub-page depicting
population growth.)



1. Discuss opposing views relating to the above illustration. Include:
 - possible explanations for how this scenario relates to future global interactions,
 - possible motivations for future terroristic activities that should be addressed,
 - possible areas for international collaboration and cooperation.
2. Develop a dialogue in which you answer the question, "Can terrorism be eliminated?" Explain your position.

Suggested Classroom Activities for Task #6

- 1.** Have students investigate economic conditions in three different regions of the world, include an industrial nation, a developing nation, a third world nation
 - Have students collect data, pictures, etc. that depict the economic conditions of each
 - Conduct a discussion on the differences between the three regions and identify conditions that might lead to terrorist type activities
- 2.** Develop and administer a survey on terrorism to your student body. Identify issues focusing on local, regional, national and international terrorism. Compile and analyze the data from the the survey. Discuss the results and the implications for the future.



Proliferation of Nuclear Weapons

Introduction

Nuclear weapons containment is at the heart of several programmatic goals of Los Alamos National Laboratory and Lawrence Livermore National Laboratory. The Laboratories are central players in safeguarding nuclear weapons. As part of this work, the Labs have established collaborative efforts with the former Soviet Union to develop comprehensive monitoring systems for nuclear materials and weapons. In addition, the Labs continue to work on developing ways to detect underground or otherwise hidden nuclear weapons production and test sites.

"A hundred generations have searched for this elusive path to peace, while a thousand wars raged across the span of human endeavour. Today that new world is struggling to be born. A world quite different from the one we've known. A world where the rule of law supplants the rule of the jungle. A world in which nations recognize the shared responsibility for freedom and justice. A world where the strong respect the rights of the weak. "

- President George Bush, 1990

This topic area focuses on our nation's ability to monitor and counter the proliferation of nuclear weapons. Built around the issue of who, what, and why political entities engage in the development of nuclear weapons, teams of teachers and students are asked to consider the production and disposition of nuclear materials sought and used by 1st, 2nd, and 3rd world nations.

Considering the devastation that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples,"....

So begins the NonProliferation Treaty, signed at Washington, London, and Moscow on July 1, 1968. The end to the possibility of nuclear war. The end of testing of nuclear weapons, and thus the end of nuclear fear. Or so it seemed.

The "Cold War" continued for another quarter century. The two superpowers, the Soviet Union (soon to be dissolved) and the United States, amassed over 70,000 nuclear weapons. But dialogue was being pursued. New treaties were being discussed as people began to think they could see a light at the end of the tunnel. Talk shifted toward cleaning up the environmental legacy.

The world had watched in horror as the two superpowers neared the brink of Armageddon. The two superpowers began to change course and were now searching for an elusive path leading to peace. They began the walk towards disarmament, toward a safer world. They had learned their lesson during the "Cold War," a lesson that had a terrifying legacy and horrendous future. And yet, there were others who had not learned from their mistakes. Others who wanted to pursue what the superpowers were beginning to eliminate.

Today, events taking place on the Indian Subcontinent have changed the rules developed during the "Cold War." Limitations and interpretations of the treaties that were developed are being stretched and broken, if not legally, then morally. Pandora's Box has been reopened and the world must now move to contain it.

"Then another horse came out, a fiery red one. Its rider was given power to take peace from the earth and to make men slay each other. To him was given a large sword." (Revelation 6:4)

Present solutions to the proliferation problem have been to limit the export of nuclear technologies. But the potential for proliferation still exists. Do we need to increase our efforts or look at other alternatives? Our future depends on resolving this issue. We must examine all facets of the problem and reach consensus, not only with ourselves, but with all factions having or considering a nuclear capability.

We must not let the unthinkable occur. We must strive to make the world a safer place to live.



Task Assignments for Proliferation of Nuclear Weapons

Task #1 – Motivation for proliferation or nonproliferation

"In the long history of the world, only a few generations have been granted the role of defending freedom in its hour of maximum danger. I do not shrink from this responsibility - I welcome it. I do not believe that any of us would exchange places with any other people or any other generation. The energy, the faith, the devotion which we bring to this endeavor will light our country and all who serve it - and the glow from that fire can truly light the world. And so, my fellow Americans: ask not what your country can do for you – ask what you can do for your country. My fellow citizens of the world: ask not what America will do for you, but what together we can do for the freedom of man. "

..... John F. Kennedy

- Inaugural Address (January 20, 1961)

Even though mankind has demonstrated disgust for war, they nevertheless have sought to develop more refined and deadlier weapons for eliminating their enemies. In the present world, humankind has developed weaponry that threatens its own existence and yet, there are those who seek to add this capability to their arsenal.

In August, 1945, nuclear weapons were used in war for the first time in history. Despite the demonstrated effects of these weapons, three nation states - the Soviet Union, Great Britain, and France - joined the "nuclear club" in rapid succession following the end of World War II. For a period of nearly fifty years, the world lived in what was termed a "Cold War," with two nuclear superpowers facing off from opposite sides of the globe. In the middle of this Cold War, the nation state China, joined the club. These countries now occupy the permanent seats on the United Nations Security Council.

Due to intense diplomatic efforts, and the collapse and break up of the Soviet Union in the 1990's, the Cold War was declared to be over. Yet, just as the nuclear superpowers began the process of drawing down and destroying their nuclear stockpiles, two additional nation states joined the nuclear club. In May, 1998, both India and Pakistan tested nuclear devices and declared themselves to be nuclear weapons states.

World wide hostility and friction have not ended. During the last fifty years, many conflicts have erupted between nation states such as; India/Pakistan, US/USSR, Argentina/Brazil, and within regions such as; the Middle East, and East Asia. The Cold War has ended, but the "race" continues.

To help us understand the issues surrounding the proliferation of nuclear weapons, we need to examine the factors that are involved in the decision whether to acquire nuclear weapons or not. Our first task, therefore, focuses on the issue of "motivation."

Your task is to consider what motivates the decision to pursue nuclear capability. You must examine decisions that have been made or that are being made by various nations today. Scrutinize these decisions in the context of nuclear proliferation, nonproliferation, and counter proliferation. Research and gather data, within the context of the four domains (science, economic, social/cultural, and political/geo-political), that help you build an understanding of the motivational issues behind these efforts.

1. Identify, describe and compare effects of nuclear proliferation efforts on a nation from the perspectives of the United States and another nation of your choice within the context of the four domains listed above.
2. Produce an overall analysis and definition of your position in regard to the motivations that are driving current decisions being made by the nations of the world to pursue a nuclear weapons capability (select two or three nations in addition to the United States, India and Pakistan for this collective study).



Suggested Classroom Activities for Task #1

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

1. Prepare for your examination of nonproliferation issues by viewing the classic films, "Fail Safe" and "Dr. Strangelove..". Discuss how failure of communication between countries, combined with a technology which eliminates human intervention, created the conundrum of this drama and farcical comedy. Could something like this really happen?
2. How do countries work together to discourage the use of nuclear weapons?
Rent and watch the movie "Hiroshima". The movie was a joint production by Japanese and American film companies. The events leading up to the bombing at Hiroshima are examined from both sides in this interesting and informative film.
3. Have the students play the "Nuclear War Card Game" (available for \$24.95 from www.flyingbuffalo.com). Discuss the game and its rules. How closely might this approximate reality?
4. Invite a speaker to come to your class. The speaker could be from any number of organizations such as Physicians for Social Responsibility, Atomic War Veterans, the Los Alamos Action Network, etc. Try to present all side of the issue, not just pro- or anti-nuclear views.

The following activities and questions are directed specifically at the task questions.

1. Have a mock meeting of the National Security Council of your "nation". Some possible members include the head of state, secretary of defense, secretary of state, head of the international intelligence agency, and secretary of the treasury. Have each of these members consider the pros and cons of pursuing a nuclear weapons program including relevant motivating factors. Each person might present "visuals" which capture and categorize the main points while convincing the other members of their point of view. Be sure to consider the four domains (political, scientific, social/cultural, and economic) in developing arguments.
2. Develop comparative charts or a database identifying nations and their nuclear capabilities. Refer to each of the domains.
3. The five permanent members of the UN Security Council are the "Big Five" nuclear states as identified by the Nonproliferation Treaty (NPT). Consider the following scenario:

You are one of the "Big Five" nations. As part of your political process, an election for your head of state is coming up this year. The two main candidates are on opposite sides of the nuclear issue. As a campaign management team, you must come up with a position on the following questions:

- What is the world's perception of the nuclear powers?
- Is nuclear status a determinant of great power status?
- What power does a nuclear state really have?
- Do we need nuclear weapons?
- What responsibility do we have to non-nuclear states?
- What are the benefits of being nuclear for our nation? The risks?

Now, prepare campaign materials like brochures, bumper stickers, position papers, and TV and newspaper ads defining your ideas on the future of your nation's nuclear program. Refer to the four domains.

4. Your firm has been hired as consultants to the government. You must prepare a report on the impact of developing nuclear weapons. You must answer the following questions:

- Why would you want nuclear weapons?
- Why have some nations with the capability chosen not to develop nuclear weapons (like Switzerland) and others to arm and then disarm themselves (like South Africa)?
- Would the world be a safer place if no nation had nuclear weapons? If all nations had nuclear weapons? Would this be a realistic goal?
- What kind of infrastructure is needed to develop nuclear weapons?
- What will it cost?
- What sacrifices would need to be made?
- How will it effect our international status? Can you truly be considered a great civilization today without having nuclear weapons?
- How could our nuclear capabilities be exploited within the framework of existing treaties and current power structures?

5. As a study group within a scientific society, you have been researching the legacy left by the development of nuclear power, including errors and accidents, and nuclear weapons, including their use in World War II and tests of them both above and below ground. Your present task is to develop a strategy for disseminating the results of your research. Design a plan for transferring this information internationally.

The preceding activities were based on the following questions. You may want to peruse these for ideas to help seed classroom discussion. You will notice that many of these questions have been incorporated into the activities.

1. Brainstorm, capture and categorize issues you feel would be relevant motivators for a nation to pursue/not-pursue a nuclear weapons program
2. Brainstorm, capture and categorize questions that need to be explored
3. Develop comparative charts or data base identifying nations and their nuclear capabilities Nuclear weapon states, nuclear capability states, non-nuclear states By nation with reference to each of the domains
4. Develop arguments that could have been used by the "Big Five" nuclear states for the development of their nuclear capabilities (work within the constructs of the four domains)
5. Considering that the five permanent members of the UN Security Council are the same as the five nuclear weapons states identified by the Nonproliferation Treaty, determine the significance of the following:
 - What is the world's perception of the nuclear powers?
 - Is nuclear status a determinant of great power status?
 - What power does a nuclear nation really have?
 - How much power does a non-nuclear nation have?
 - Does a nuclear nation care how it is perceived by the rest of the world?
 - Do great powers believe they need nuclear weapons? Why?
 - The five members of the UN Security Council are all nuclear powers. Is it just a coincidence?
 - How do you know?
 - Why did South Africa arm itself with nuclear weapons? Why did it then disarm?
 - Why do nations want nuclear weapons? Nuclear power? (think within the four domains)
6. What challenges will nations/the world likely face when reducing the number of nuclear weapons?
 - Will the world be a safer place if NOBODY has ANY nuclear weapons?
 - What would be considered a reasonable number of weapons for the US and Russia to maintain?
 - What possibilities, positive/negative, might exist if all nations had nuclear weapons capability? (think within the four domains)
7. Consider this: Following the recent South Asian nuclear tests, a Japanese diplomat was heard to remark that Japan was now the only great civilization without nuclear weapons...
 - What did he mean by that statement?
 - What will this type of viewpoint mean for the future of nonproliferation?
8. Consider the few nations that have nuclear capability, but do not have a nuclear weapons program:
 - Why do they chose to dismantle or discard plans for nuclear weapons capability?
 - What might motivate them to change direction and begin a nuclear weapons program?

9. Consider the effect of the nuclear legacy on the nuclear weapons states.
- What were the lessons learned?
 - What are the effects of these lessons on newly developing nuclear states?
 - How can these lessons learned be transferred and applied without political repercussion?
10. What kind of national infrastructure would a nation have to have to be able to develop nuclear weapons? What sacrifices might be necessary?
11. The effects of nuclear weapons on both humans and the land have been studied in Japan and at national weapons testing sites.
- What have we learned from these studies?
 - Does the knowledge of the effects of these weapons have an impact on a nation's decision to become a nuclear power?
12. Investigate the history of treaties in the 20th Century and detail which ones have been effective, which ones proved ineffective. Why?

Issues that may be included in your planning:

Scientific domain <ul style="list-style-type: none"> • Technology • Status • Spin-offs • Weaponry • Environment • Energy 	Economic domain <ul style="list-style-type: none"> • Concessions • Status • Effects • Growth • Standard of living •
Political domain <ul style="list-style-type: none"> • Security • Status • Pride • Concessions • Military 	Social/Cultural domain <ul style="list-style-type: none"> • Status • Human nature • Religion • National pride • Standard of living

Task #2 – Technology

"In an enterprise such as the building of the atomic bomb the difference between ideas, hopes, suggestions and theoretical calculations, and solid numbers based on measurement, is paramount. All the committees, the politicking and the plans would have come to naught if a few unpredictable nuclear cross sections had been different from what they are by a factor of two."

..... Emilio Segre

- quoted in "Making of the Atomic Bomb"
by Richard Rhodes

The "Industrial Age" has given way to the "Information Age". The advent of technology has increased the pace of this transition especially in the development of nuclear capabilities. Understanding of the atom has driven scientists in developing better ways to "see" the inner workings of the nucleus. From Aristotle to Newton, Rutherford and the Curies, to Einstein, Fermi, and Oppenheimer, scientists have continually attempted to further their understanding of our world (see the Historical Perspective section for more detailed work in this area).

Technology has aided the shift from the simple to the complex, from big to little, and from low yield to high yield. Delivery methods, whether it be for civilian or military purposes, have simultaneously simplified and added to the complexities of our daily lives.

Once the "arms race" began, the rush for developing bigger more powerful weapons in greater numbers contributed to emerging technologies. Treaties between the "nuclear nations" stopped traditional above-ground testing and forced nations to develop new technologies to ensure the reliability of their stockpiles. The high cost of these technologies was thought to be a deterrent to the development of nuclear capabilities, but recent history has proven this false.

As we consider proliferation and nonproliferation efforts, both military and civilian applications are motivators for a nation to pursue a nuclear capability. A nation may not have the fiscal resources to develop modern and sophisticated designs, but we must remember that weapons can still be developed with "old" technologies.

To help us gain an understanding of the level of technology necessary for developing and maintaining nuclear capabilities, we need to investigate the complexities of this issue.

Our second task focuses on the technologies embedded within the proliferation/nonproliferation/counter-proliferation efforts.

Your task is to consider issues surrounding the technologies needed to pursue nuclear capability. You must prepare researched responses to the questions listed below, within the context of the four domains (science, economic, social/cultural, and political/geo-political). The focus of this benchmark is the differing nuclear technologies that have been used or are being developed by various nations today. Research, gather data, and thoroughly demonstrate your understanding of the technologies and the technological issues.

- 1.** Compare and contrast the technological efforts of developing a nuclear weapon in the United States during World War II and in Pakistan in the present era within the context of the four domains.
- 2.** How is the use of technology different or the same in nuclear weapons proliferation, nonproliferation, and counter-proliferation efforts? How does the level of sophistication of technology affect the issue of stockpile stewardship?
- 3.** Produce an overall analysis regarding a nation's program for acquisition and maintenance of technologies needed to develop or refine nuclear weapons programs (select two or three nations for this collective study).



Suggested Classroom Activities for Task #2

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the benchmark, they are not directed specifically at any benchmark question.

Prepare for your examination of nonproliferation issues by viewing the film "Fat Man and Little Boy" (research and do technical critique {Are they doing the science right?} or {take notes during the movie and write a "recipe" for creating a nuclear device with questions on what you will need to know.})

The following activities and questions are directed specifically at the benchmark questions.

1. As a museum curator in the year 2121; prepare exhibits about early nuclear weapons development in the United States and in Pakistan or India.
2. Produce an infomercial to collect donations for your nations program to acquire and maintain nuclear weapons.
3. As a Nuclear Engineer, write a proposal analyzing your nations program for acquisition and maintenance of the technologies necessary for the development or refinement of a nuclear weapons program. Be sure to consider the four domains and all relevant safety and security issues.
4. Your supervisor (Director of the CIA) has instructed you to chart the technological capabilities needed by different countries to either proliferate, nonproliferate, or counter-proliferated.
5. Create a web page linking the effect of technology on proliferation, nonproliferation, and counter-proliferation.
6. Produce comic strip(s) documenting early nuclear weapons development in the United States and Pakistan or India.
7. Investigate how nuclear weapons are made including the underlying technologies and resources needed. Make a model (schematic) of your bomb and attach an addendum summarizing how and where you will obtain the needed materials.

The preceding activities were based on the following questions. You may want to peruse these for ideas to help seed classroom discussion. You will notice that many of these questions have been incorporated into the activities.

1. Brainstorm technologies you feel would be relevant for a nation to pursue/not-pursue when developing a nuclear weapons program

2. Brainstorm questions that need to be explored
 3. Develop comparative charts or data base identifying nations and their nuclear capabilities, the level of technologies they can afford within their fiscal means, the level of technology they are pursuing outside of their fiscal means
 4. Compare the economic positions of the "Big Five" during the time that they developed their nuclear capabilities.
 - How have these positions changed over the last four decades?
 - How did the economic conditions during these time effect the other domains within these nations?
 5. What technological challenges will nations/the world likely face when reducing the number of nuclear weapons?
 6. Once a nation has a nuclear arsenal, how is it to be maintained?
 7. What defines the concepts of reliability and safety within a nuclear arsenal? What part does technology play?
 8. Does technology make a difference? Investigate methods of monitoring and surveillance (the technologies needed/used) that help to assure that treaties, particularly those regarding nuclear weapons and nuclear materials, remain viable.
 9. What does a nation learn about its nuclear weapons by conducting nuclear tests?
 10. What part does new missile technology play in the global concern for nuclear weapons proliferation?
 - Why is this an issue? How does it relate to the four domains?
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Task #3 – Global Concerns

"It's better to die on your feet, than live on your knees. "

..... Dolores Ibarruri

"If we shake hands with icy fingers it is because we have burnt them so horribly before."

..... Logan Pearsall Smith

Positions held by nations on the issues of proliferation, nonproliferation, counter proliferation and disarmament are argumentative and complicated. The belief systems, political and cultural, drive decisions made by geo-political entities that are reflected within global interactions. Positive interpretations of these interactions require cooperation and understanding between nations. Lack of knowledge and understanding leads to misinterpretations and fuels conflict.

The most common method of analyzing international positions and agreements is by examining existing treaties. Treaties have been written to address issues surrounding the development and proliferation of nuclear weapons. These include SALT, NPT, START, CTBT and others that create nuclear weapon free zones or no first use policies.

Treaties can be hard to enforce. Accountability and verification of compliance to treaty agreements presents a daunting task to the nations of the world. Several major international organizations deal with nuclear issues including the United Nations (UN), the International Atomic Energy Agency (IAEA), the Nuclear Suppliers Group (NSG) as well as a number of activist organizations.

Collaborative efforts between the nuclear superpowers have resulted in political and technological avenues that address the issues of accountability and verification. Ensuring the compliance to international agreements without infringing on the sovereignty of a nation can be a sensitive endeavor. Diplomatic issues must be considered in any negotiation surrounding treaty development and verification.

An informed citizenry that understands current global policies, motivations and situations is necessary for the development of comprehensive, effective policies that will shape the future of the nuclear world. Therefore, this task focuses on identifying and understanding concerns that confront the global community.

Your task is to explain the concerns of members in the global community regarding regional development and proliferation of nuclear weapons. This task focuses on the identification and analysis of global concerns. You will describe these concerns, examine them within the context of the four domains (scientific, political, social/cultural, and economic) and determine possible current and future implications for the world community.

1. Compare and contrast the implications of a current international treaty and its verification process dealing with proliferation/nonproliferation of nuclear weapons. Examine the treaty from the perspective of one nation in each of the following categories:

- "old nuclear" nations (the Big Five)
- "new nuclear": nations
- "non-nuclear": nations

2. Using the treaty you identified in question #1, examine the issues of accountability within the areas of security, safety, the environment, public health, and ethics. From the perspective of your 3 selected nations, prepare arguments on accountability issues that each nation would deliver at a United Nations forum.

3. Develop a collaborative paper regarding the development of a comprehensive, effective nuclear weapons nonproliferation treaty that will encompass all nations. Describe the elements that would ensure that the treaty would be ratified and adhered to by the global community.



Suggested Classroom Activities for Task #3

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

The following activities and questions are directed specifically at the task questions.

1. You are the executive producer of the TV show "Twentieth Century". You are doing a show on the effects of nuclear weapons and the current treaties controlling them. Prepare a script or show which describes the effects and explains the relevant treaties and assesses their effectiveness.

2. Consider the following scenario: Country A has recently developed a device which is capable of breaking any encryption code. Country B has been researching similar devices but has not been successful yet. Country C has an economy driven by information systems and banking and is, therefore, very intimidated by the invention of the device. Your task is to develop a treaty between these countries which will restrict the use of the device, limit or stop its proliferation, provide safety for other countries who are concerned about the use of the device, and verify all treaty points. Consider the four domains and the following questions:

- Why do international treaties work? Why not?
- What does it take to make a treaty successful?
- What incentives would make all these countries "join" the treaty?

3. Would you expect a car that has been sitting idle for 10 years to operate properly? Why or why not? What if you are given the job of keeping the vehicle in "running condition" but you are not allowed to actually start the car or drive it. Prepare a proposal that can accomplish your goal under the stated restrictions. Identify which elements involve maintenance, replacement, test modeling, etc.

4. As a new member of the LANL team, you are being groomed for a position in the stockpile stewardship team. Your mother is very proud of you, but your spouse, a physician member of "Physicians for Social Responsibility", is not comfortable with your new job. Survey the objectives of our stockpile stewardship program. Analyze why people might mistrust the intentions of the program and the mechanisms envisioned to reach the program's goals. Prepare a convincing argument to put before your spouse (over a candlelight dinner, of course).

The preceding activities were based on the following questions. You may want to peruse these for ideas to help seed classroom discussion. You will notice that many of these questions have been incorporated into the activities.

1. Brainstorm nuclear weapons issues you feel would be relevant to global concerns as a whole.
2. Brainstorm questions that need to be explored
3. List possibilities that would cause a nation determined to use nuclear energy for peaceful purposes to suddenly change its mind and embark on a weapons program
 - What would it have to do?
 - How would the rest of the world find out about it?
 - What could the rest of the world do about it?
4. For what peaceful purposes might a country enrich uranium or reprocess plutonium? How can you tell when it's for peaceful purposes, and when they're trying to make a bomb?
5. Revisiting an activity from BM#1, investigate the history of treaties in the 20th century and detail which ones have been effective, which ones proved ineffective. Why?
 - From the perspective of the four domains, give arguments why some international agreements have worked and others have not.
 - What does it take to make an arms control treaty successful?
 - Which areas seem to be weak and need of strengthening?
 - What can be done to strengthen them?
6. Consider the impact of international treaties on a nation wishing to pursue a nuclear capability
7. What are the various international treaties negotiated to control nuclear arms proliferation? How effective is each?
 - Can treaties be trusted? Why?
 - What is the relationship between the NPT, CTBT, FMCT, and NWFZ treaties?
 - What nonproliferation value is there in limiting the kinds of nuclear testing that can be done?
 - What role does verification play in international treaties? What technical measures are available to verify compliance with various nuclear weapons treaties?
 - What does a nation sacrifice by joining the CTBT?
 - How would you respond to charges that no piece of paper ever protected the citizens of a nation from attack?
 - It is a common conception that if there is a "breaking of the rules", that there must be some sort of punishment. What kinds of punishments are available when nuclear treaties are broken? What kinds of punishments can be administered to nations who have not signed the current treaties?

- How should the U.S. respond to claims that the NPT amounts to "nuclear apartheid"? (India statement)
 - Why does so much effort go into constructing these kinds of treaties?
 - Why did Argentina and Brazil both refuse to sign the Nonproliferation Treaty (NPT)?
8. What are the objectives of stockpile stewardship?
9. Why do other countries (and some Americans) mistrust the U.S. government because of the stockpile stewardship program? What do you think?
10. Is stockpile stewardship a monstrous evil or is it a responsible policy? Explain.
11. Is deterrence based on nuclear weapons availability ethical? Why
- What political (social, economic) ramifications does this stance have on a nation?
12. What is a responsible policy that the world's nations ought to adopt on nonproliferation?
13. Consider this: "We are a multicultural world and we don't want to be."
- What implication does this quote have for the future of the world?
 - How can nations with an ethnic majority pursue peaceful resolution to global concerns?
 - What ramifications/implications does this statement have within a multicultural nation such as the United States?
14. How do we define the conditions so that a nation feels secure in a nuclear world?
15. How will the life support systems of the Earth be affected by varying degrees of nuclear exchange?
- Would the effects on the world's ecosystems be irreversible?

Discussion topics

What	Who	Why	When
<ul style="list-style-type: none"> • environment • political stability • social stability • ethics • economic growth 	<ul style="list-style-type: none"> • citizens • groups • politicians • rulers 	<ul style="list-style-type: none"> • health • environment • safety • security 	<ul style="list-style-type: none"> • current • short term • long term

Task #4 – Future Solutions

"My interest is in the future, because I am going to spend the rest of my life there."

..... Charles F. Kettering

"Who controls the past controls the future. Who controls the present controls the past."

..... George Orwell

What is our vision of the perfect world? How do we achieve this vision? How do we maintain it? Starting from the imperfect foundation of the present with all its complexities and animosities, human beings are hard pressed to construct a Shangrila or even a working model of this vision. However, it is imperative that we attempt to step off the precipice of nuclear destruction and strive towards a better, safer world.

Many vexing problems, such as global balance of power and international cooperation must be considered. Global and regional instability issues must be addressed and resolved. Mechanisms need to be developed to promote the peaceful use of nuclear technologies while constraining and/or preventing the use of nuclear weapons. The examinations of the impact of nuclear technology on the environment and the global economy must be made as we attempt to move into the future with a deliberate plan for global improvement.

In pondering the future of the nuclear world, we should realize that our present and future endeavors are built upon the experiences of the past. As we begin to speculate about new situations and scenarios, we need to step back for a moment and reflect on what we have learned from the previous benchmarks. In developing a vision of the nuclear world, we need to continue considering the past and current realities of the world in general as we begin to narrow our research for the resolution of specific areas of concern.

The role that things nuclear will have in future world will include

- the global environment
- nuclear weapons
- nuclear energy
- medical and industrial applications
- public attitudes and
- institutional responses

A vision of the future needs to be defined, one that can simultaneously reduce dangers while allowing the benefits from nuclear technologies to be realized. In order to create

such a vision, efforts should be focused to examine pathways leading to this future and to identify steps that could begin this process. Of particular interest are efforts in the area of proliferation and nonproliferation of nuclear weapons and possible impacts on important nuclear related areas of the future.

To help develop an understanding of the future of nuclear weapons proliferation/nonproliferation, we need to synthesize the complexities of this issue. Our fourth task focuses on the future of the nuclear world as a result of the success of proliferation/nonproliferation/counter-proliferation efforts.

Your task is to develop visions for the future of nuclear weapons proliferation/nonproliferation efforts that reflect global and regional concerns and understandings.

This task focuses on the identification and analysis of future scenarios. In developing visions for the future of the nuclear world, you will describe scenarios examine them with the context of the four domains (scientific, political, economic, and social/cultural). To determine possible current and future implications for the world community, teams need to consider the past and current realities of the world in general as they begin to focus their research results toward specific areas of concern.

1. Develop two written scenarios for the future. The first driven by nonproliferation efforts, the second by proliferation efforts. In both scenarios, identify the positive and negative implications that would occur in the interactions of the four domains. Teams should include the following issues in their vision:

- environmental
- economic growth
- political stability
- social stability
- accountability
- uses of nuclear materials and technology



Suggested Classroom Activities for Task #4

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

1. Preview one or more of the following videos/movies which have plot lines based on destruction of civilization by nuclear holocaust or some other catastrophe.

Video List

- Dr. Strangelove
- Silent Running
- Logan's Run
- Planet of the Apes
- Road Warrior
- The Day After
- etc.

Use segments or the entire video and have students:

- Analyze the possible causes of the scenario shown (include the four domains).
- Write a script for a sequel to the story presented.
- Create a solution to the problems illuminated in the first task.

2. Divide the team into four subgroups, each to address one of the following possible future perspectives:

- Nuclear proliferation with overall positive results
- Nuclear proliferation with overall negative results
- Nonproliferation with overall positive results
- Nonproliferation with overall negative results

Each subgroup will present and explain their work to the whole group in one of the different formats listed below. The whole group should provide feedback/critique to the presentation.

- Political cartoons
- Comic strips
- Short stories or fictional diaries
- News scripts
- History of 1999 from the perspective of a high school student in 2050.

3. Download the Nukefix program (<http://www.nukefix.org>) to a PC platform computer and use it with students to illustrate some of the different possible results of nuclear weapons use.

Storage and Disposition of Nuclear Materials

Introduction

Due to the international movement toward the dismantling of nuclear weapons as a result of the Nonproliferation Treaty, the President of the United States has declared 200 tons of weapon fissile material (plutonium) as excess for inspection and storage. Similar efforts have been made by the former Soviet Union. As a result of their combined efforts, the world is now concerned with the monitoring of the excess radioactive material to ensure that it is stored properly, inventoried, and kept out of the hands of rogue nations. This has become even more important with the addition of India and Pakistan to the list of countries possessing nuclear weapons.

In addition to the excess radioactive materials from dismantled nuclear weapons, we must also be concerned with radioactive materials from nuclear power plants, industrial uses, university research, and medical facilities.

Radioactive waste materials are classified in five categories; Low level waste, low level mixed waste, Transuranic waste, high level waste, and hazardous waste. As we investigate the various options for disposition of these types of waste, we will have to learn the make-up of each, what the hazards are, and the type/level of radiation given off by each. We need to inform ourselves of the different types of radioactive materials that are used today and of those used in the past. We need to consider issues of security, proliferation, terrorism, energy needs, environmental, safety and health. We need to look at existing laws and regulations governing radioactive materials. Only through this knowledge can we make informed decisions as how to handle each type of waste.

A little over 50 years ago, work at Los Alamos and elsewhere in the world set in motion developments in military and civil applications of nuclear science and technology. Over the years these ongoing developments have shaped history. The resulting "Nuclear Age" has had a significant impact on many aspects of society -- nationally and internationally.

As a result of the initiative to develop a nuclear weapon to turn the tide in favor of the Allies in World War II, many radioactive materials were created as by-products of the Manhattan Project. It then became necessary to control these materials. The attitude toward nuclear weapons at that time was captured in the following quotation:

"We are here to make a choice between the quick and the dead...Science has torn from nature, a secret so vast in its potentialities that our minds cower from the

terror it creates. Yet terror is not enough to inhibit the use of the atomic bomb...We must provide the mechanism to... preclude its use in war."

- Joseph Cirincione

Current History: A Journal of Contemporary World Affairs, May 1995

These words contained the recognition that the control of radioactive materials would be a significant problem for the world. The United States and Russia had control of most of the radioactive materials in the early years of weapons research and development, but radioactive materials were considered powerful and attractive to countries who also wanted military power. It was the fear and interest in such a potentially dangerous material which led to the development of an international movement toward the dismantlement of nuclear weapons. The result was the Non-Proliferation Treaty (NPT). The world treaty signed in 1970 called for the control of nuclear weapons, but the NPT has not been the complete answer to the problem of controlling radioactive materials.

For example, in testimony given at the U.S. Foreign Affairs Committee hearing in March, 1993, the panel reported that the following countries are to be known nuclear weapons powers: the United States, the Former Soviet Union (FSU), Belarus, Kazakhstan, the Ukraine, the United Kingdom, France, and China (India and Pakistan can now be added to this list). Meetings among the nations have been recently held to make Russian warheads safe from terrorists. Brazil, Argentina, and South Africa have the capabilities but have renounced their weapon's programs. Two other nations, Iraq and North Korea, are suspected of having nuclear weapons capabilities, but since they refuse to conform to the terms of the NPT, it is difficult to know exactly what their status is.

The question is: What should be done with the excess radioactive materials from the dismantlement of nuclear weapons? Related to the question are other concerns such as: How should these materials be inventoried and monitored? How should they be kept away from rogue nations? How will the environment be safeguarded from contamination by those materials?

Task Assignments for Storage and Disposition of Nuclear Materials

Task #1 – Use of Radioactive Materials

"Nuclear materials present the capability of mankind to destroy itself,"

"So I hope all of you are working in this important field."

... we want to strengthen the spirit of cooperation for the security of mankind."

- Vladimir Shmelev, deputy director of the Kurchatov Institute's
Division of Nonproliferation and Control - 1995

Radioactive materials have many uses, from benign uses creating light for runways and exit signs, to highly destructive uses as epitomized by nuclear weapons. Röntgen first demonstrated the release of energy from a substance with a cathode ray tube. This discovery would send the world of physics into the modern age. The 2300 year-old concept of the atom was about to change. As other physicists began to unravel the mystery of the atom, the unsplittable particle would soon become splittable. Einstein released the genie with the publication of his famous equation stating that energy was equal to the mass of an object times the square of the speed of light. With this simple equation, Einstein demonstrated that energy and mass were just two facets of the same thing.

Our first task focuses on the use of radioactive materials. From commonly known uses of radioactive materials, the production of energy, and the development of nuclear weapons, other peaceful uses of the materials are sometimes forgotten. Using these as reference points, focus your research in relation to the multiple uses of radioactive materials as they relate to the four domains (scientific, economic, political, social/cultural).

"Peaceful applications of nuclear energy -- and all the promise they entail for humanity -- are paradoxically often perceived in juxtaposition with the prospects of nuclear weapons' proliferation and nuclear war. The mixed perception is understandable: the materials, knowledge, and expertise required to produce nuclear weapons are often indistinguishable from those needed to generate nuclear power and conduct nuclear research."

- by Mohamed Elbaradei, Edwin Nwogugu, and John Rames

Your task is to compare and contrast the endeavors of nuclear science and technology for "peaceful and military" uses.

You must examine how nuclear science and technology today is used. Scrutinize these uses in the context of the four domains (science, economic, social/cultural, and political/geo-political). Research and gather data that help you build an understanding of the uses of radioactive materials.

This task focuses on the use of radioactive materials. Using this as your reference point, address the following:

1. Identify the varied uses of radioactive materials. Create a chart listing each use, the type of radioactive material used, the type of radiation given off by the nuclear material, the type and amount of shielding needed to protect users, and the specific applications for which it is used. What are the pros and cons for each use?
2. Compare the production of energy in nuclear power plants with that in nuclear weapons?
3. From the perspectives of pro- and anti- nuclear energy advocates, develop materials to be presented at a rally defending each groups agenda on the use of radioactive materials.
5. Develop a critical analysis of the continuance of producing electrical power with fossil fuels.



Suggested Classroom Activities for Task #1

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on the use of radioactive materials. Using this as your reference point, address the following:

- 1.** Have a mock class dialogue between the Secretary of the Department of Energy and the president of "Citizens for a Safe World" (CFW) on the subject of using radioactive materials in the public sector. Have your students identify possible agendas for the CFW and develop a number of scenarios between the two debaters. Assign one student the role of Secretary Richardson and another the role of the CFW president. Each student should prepare themselves to prevail at the end of the debate. Both sides should have supportive members to supply needed documentation for the debate. A judging panel made up of other students will decide on the winner of the debate. Each student might present "visuals" which capture and categorize their ideas while convincing the panel members of their point of view. Be sure to consider the four domains (political, scientific, social/cultural, and economic) in developing arguments.
- 2.** Develop comparative charts identifying new technologies developed for medical uses of radioactive materials. Refer to each of the domains (How did the new technology affect each domain?). What are the benefits, the hazards for each use?
- 3.** Give examples of industrial uses of radioactive materials.
- 4.** Develop and conduct a survey to determine your communities perception of uses of radioactive materials. Interpret the results of the survey. What conclusions do you draw?
- 5.** Describe in your own words the responsibility a government has to the general population when it comes to using radioactive materials for private industrial use?
- 6.** As the public relations officer of the "Municipal Hospital", prepare informational materials like brochures, bumper stickers, position papers, and TV and newspaper ads delineating the future needs of the hospital for purchasing and using radioisotope technologies and testing equipment for a newly planned nuclear medicine wing of the hospital. Refer to benefits as they pertain to the four domains.
- 7.** As a study group within President Clinton's scientific advisors office, you have been researching the legacy left by the development of nuclear technology, including errors and accidents during the "Cold War". Your present task is to develop a strategy for disseminating the results of your research and the plan to expand the use of radioactive

materials in the public sector. Design a plan for transferring this information to each of the fifty states regulatory committees.



Task #2 – Types of Radioactive Waste

"Dr. Bertram Wolfe, a respected statesmen in the field of nuclear energy (retired corporate executive with General Electric and former President of the American Nuclear Society), once said that judging nuclear energy from the standpoint of the waste issue was a bit like judging the merits of parenting from the vantage point of the diaper. Any system (human or mechanical) that results in some useful output also generates waste. so the question is not whether waste exists; rather, it is the net cost of dealing with the waste, both in terms of health effects and environmental impact."

He went on to say, "...that one of the great advantages of nuclear energy is that the waste problem is so easily solvable. In fact, nuclear energy may be the first large industry in history that is capable of removing essentially all its waste from the biosphere."

(from *America the Powerless*, Alan E. Waltar, pg.108)

The greatest fears arising from skeptics of using radioactive materials are (1) what radioactivity will do to us and our unborn generations, (2) how do we keep it from exploding, and (3) what do we do with the waste materials after we use it. Although other aspects of nuclear energy stir the emotions, radioactive waste bothers most people. Skeptics would also point out: If the radioactivity can really last thousands of years, won't we be in danger? And if we could convince them that radioactive materials could be safely removed from the environment, they would then question the safety of transporting the materials to sites where they can be adequately disposed.

Our second task focuses on the types of radioactive waste and radioactivity. To understand what is meant by radioactive waste, we need to look at the makeup of the waste, the volume of such waste, and the longevity of the radioactive decay process before we can begin discussing how to dispose of it. Using this as reference point, focus your research in relation to the types of radioactive wastes as they relate to the four domains (scientific, economic, political, social/cultural).

Your task is to compare and contrast the different categories of radioactive wastes. You must examine how radioactive wastes are produced, how they are stored and eventually disposed. Scrutinize the importance of characterizing radioactive wastes in the context of the four domains (science, economic, social/cultural, and political/geo-political). Research and gather data that help you build an understanding of the uses of radioactive materials.

This task focuses on identifying radioactive wastes. Using this as your reference point, address the following:

- 1.** Identify and characterize the three forms of ionizing radiation. What inconsistencies exist in the general populations understanding of radioactivity and radioactive hazards?
- 2.** Distinguish between the general populations understanding of ionizing radiation and non-ionizing radiation and the scientific facts about each.
- 3.** Identify and characterize the 5 major categories of radioactive wastes.
- 4.** What are the implications (within the four domains) of the definitions for each type of radioactive waste?
- 5.** Compose a magazine article, complete with pictures, quotes, text, informing the general population about radiation and radioactive wastes. Include the science, health and environmental hazards and/or benefits.



Suggested Classroom Activities for Task #2

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on radioactive wastes and radioactivity. Using this as your reference point, address the following:

1. Create a series of charts/graphs depicting the amount of radiation (percentage of total radiation an average American is exposed to each year) from the following sources:

Natural

- terrestrial
- cosmic
- radon
- internal

Manufactured

- medical x-rays
- nuclear medicine
- consumer products
- occupational
- fallout
- nuclear fuel cycle
- miscellaneous

2. Create a chart of the following elements. Indicate the type of radioactivity emitted (alpha, beta, gamma) and the half life (in minutes, days, or years)

- Uranium-238
- Thorium-234
- Protactinium-234
- Uranium-234
- Thorium-230
- Radium-226
- Radon-222
- Polonium-218
- Lead-214
- Bismuth-214
- Polonium-214
- Lead-210
- Bismuth-210

- Polonium-210
- Lead-206

3. Create display materials that explain the difference between rads, rems, and millirems.

4. Have students describe different types of cell damage that may result from a radioactive exposure. What factors must be considered when describing the relationship between exposure and actual consequences? Hold a discussion on the hazards and benefits of exposure to radiation.



Task #3 – Issues and Concerns

"The nuclear industry denies our children a future, and instead condemns them to live on an irradiated planet among ever-growing piles of deadly radioactive waste. We are here to end nuclear colonization of our communities and commit ourselves and children to a nuclear free Northeast. "

- from the Citizens Awareness Network web site

Fear of the unknown drives people to extremes. In past times people have been sacrificed to the gods to stop volcanic eruptions, earthquakes, and disease. But as we learned more about these natural catastrophes, we learned that we could control some things and others we could not. Sacrifice within the "civilized" world no longer exists. Is this true within the nuclear world? Are issues and concerns based on lack of knowledge or do they have merit? Are people making decisions based on half-truths, selective fact dissemination, and fear? As Fox Mulder says, "The Truth is Out There."

Our third task focuses on the issues and concerns regarding the storage and disposition of radioactive waste. To understand these issues and concerns, we need to investigate them from the perspectives of pro- and anti- nuclear groups. Using this as reference point, focus your research on issues and concerns within the context of the four domains (scientific, economic, political, social/cultural).

Your task is to compare and contrast the different issues and concerns regarding radioactive wastes. You must examine differing perspectives regarding radioactive wastes, how they are stored and eventually disposed. Scrutinize the importance of disseminating factual data about radioactive wastes, storage and disposition, transportation, health hazards/benefits, the environment, etc. within the context of the four domains (science, economic, social/cultural, and political/geo-political). Research and gather data that help you build an understanding of the issues and concerns.

This task focuses on identifying issues and concerns regarding storage and disposition of radioactive wastes. Using this as your reference point, address the following:

1. Identify and describe three issues and concerns in the area of security of radioactive waste materials. Make a distinction between assumptions made by anti-nuclear activist groups and by pro-nuclear groups/agencies.
2. State a point-of-view from an anti-nuclear groups perspective regarding the legacy of the "Cold War" and nuclear state's weapons production. Which areas are justified

(supported by fact) within their conclusions and which areas are non-supported? Propose a rebuttal to their point-of-view that would be acceptable to them.

3. Develop a point-counterpoint script (60 Minutes style) on the transportation of radioactive waste materials from one state to a distant state. Include dialogue on

- security
- environment
- safety
- health

4. Design and develop a display regarding the safety issues for the shipment of low level radioactive waste materials. One part of the display should promote the Department of Energy's position and another part should promote the position of an anti-nuclear group. Compare the two positions and appraise the impact that each display would have on the general population.

Suggested Classroom Activities for Task #3

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on issues and concerns regarding radioactive waste. Using this as your reference point, address the following:

- 1.** Hold a class discussion on the use of low level radioactive waste material for a terrorist attack. Identify potential targets and impacts of such an event.
- 2.** The legacy of the U.S. nuclear weapons program expands over the past 50+ years. Identify lessons learned from this legacy.
- 3.** Since the end of the "Cold War", the U.S. and the former Soviet Union have been collaborating on issues dealing with radioactive materials (nuclear weapons, production facilities, and radioactive wastes). Discuss how this collaboration fits with the security issues of the United States.
- 4.** Make a list of anti-nuclear groups. Identify their location, their philosophy, their agenda, and their most probable "targets".
- 5.** Describe the effects of external exposure to alpha radiation from Plutonium.
- 6.** Hold a class discussion on the hazards/benefits, strengths/weaknesses of energy production using:
 - coal
 - fuel oil
 - solar
 - wind
 - LEU
 - HEU
 - Pu
- 7.** Role play a television interview on "Good Morning America with Charlie moderating" the dialogue between Dr. Helen Caldicott and Secretary Bill Richardson.
- 8.** Develop and administer a questionnaire to determine issues and concerns of your local community toward shipment of radioactive wastes to the Waste Isolation Pilot Plant in Carlsbad, NM. Interpret the results of the questionnaire and hold a class discussion on how to address the identified issues and concerns.

Task #4 – Laws and Regulations

Relations have been less than harmonious between the federal government and the states that either contain identified sites for radioactive waste management facilities or fear they may be next on the list. In fact, more than a dozen states, responding to pressure from their citizens, have enacted laws intended to prohibit flatly or to make it difficult to establish radioactive waste disposal facilities within their borders. However, such prohibitions on radioactive waste facilities may not pass constitutional review because of conflicts with the commerce clause of the U.S. Constitution.

Why do many states and local governments (and their general constituents) want to restrict or prohibit radioactive waste disposal and even temporary storage within their boundaries? Possible reasons include adverse experiences with other federal and private projects involving hazardous substances which have made states wary of possible future problems from radioactive waste facilities. Citizens and state and local officials want assurances that the facilities will be properly constructed and operated, and that they will pose no significant risks to people or to the environment now or in the future. Some want their states to play no part in disposal or storage under any conditions.

Western states feel they have long been targeted for hazardous facilities. These states have been sites for many federally sponsored hazardous activities in the past, including uranium mining, milling, and tailings disposal; nerve gas production, testing, and storage; and atomic bomb testing. Often, these remote locations were selected to minimize risk to the population at large. But as one Westerner put it, "The government has used the wide open spaces as a dumping ground for almost four decades and inflicted a lot of wounds on us. Well, we've just had enough." On the other hand, some people living near potential sites welcome radioactive waste repositories or storage facilities for the economic benefits they hope they will bring.

No legislation can guarantee agreement between states and the federal government. Problems are inevitable since state, local, and federal governments have different responsibilities and often different goals.

Our fourth task focuses on the laws and regulations regarding the storage and disposition of radioactive waste. To understand these laws and regulations and their impact, we need to investigate them from the perspectives of the various government entities and their represented constituencies. Using this as reference point, focus your research on laws and regulations within the context of the four domains (scientific, economic, political, social/cultural).

Your task is to compare and contrast the different laws and regulations (international, national, regional, and state) regarding the storage and disposition of radioactive wastes. You must examine differing perspectives that direct the creation of laws and regulations regarding radioactive wastes, how they are stored and eventually disposed. Scrutinize the importance of controlling, monitoring and inventorying radioactive wastes, storage and disposition, transportation, health hazards/benefits, the environment, etc. within the context of the four domains (science, economic, social/cultural, and political/geo-political). Research and gather data that help you build an understanding of the laws and regulations.

This task focuses on identifying issues and concerns regarding laws and regulations for the storage and disposition of radioactive wastes. Using this as your reference point, address the following:

- 1.** Governments play numerous roles in radioactive waste management. On one hand, they may be active promoters of nuclear research and development programs, but on the other hand, they are the regulators of things nuclear. This dual role often leads to complex relationships and overlaps between various governmental agencies. Identify and describe three areas where this complex relationship would seem to be in conflict with each other.
 - 2.** State a point-of-view from an anti-nuclear groups perspective regarding the effectiveness of legislation governing the storage and disposition of radioactive wastes within your state boundaries. Which areas are justified (supported by fact) within their conclusions and which areas are non-supported? Propose a rebuttal (appropriate legislation) to their point-of-view that would be acceptable to them.
 - 3.** As the governor of the Great State of "Not in my Back Yard", a state with a number of industries using/producing nuclear materials, propose legislation banning the storage and disposition of radioactive wastes within the state boundaries. What ideas would justify the ban and the eventual transportation of the "banned material" through the state and across other state lines.
-

Suggested Classroom Activities for Task #4

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on laws and regulations governing radioactive waste. Using this as your reference point, address the following:

- 1.** Role play a Senate debate on the need of creating a specialized agency with the Environmental Protection Agency (EPA) to regulate and monitor transportation and storage of radioactive wastes.
- 2.** Design and develop a traveling display to inform the public of the governments point-of-view for the transportation of storage of radioactive wastes. One part of the display should promote the Department of Energy's position and another part should promote the position of an anti-nuclear group.
- 3.** Develop an one-act play depicting lawful conflict between an anti-nuclear group and a government agency representative over the transportation of radioactive wastes through your community. Include major points of concern the activist group would likely have and the legislation that would support the government representative.
- 4.** Identify laws regulating radioactive wastes in other countries.
- 5.** Discuss the merits of producing legislation based on scientific knowledge today that is to govern disposition of the radioactive waste 10,000 years in the future.
- 6.** Hold a class discussion on the hazards/benefits, strengths/weaknesses of storing radioactive wastes in your state.
- 7.** Create a web page that informs your local community on current, past and future legislation dealing with radioactive waste. Include viewpoints of pro- and anti-nuclear groups, as well as the federal and state governments. Provide an area for general comments from community members on the issues. As the web site developers, you should moderate the dialogue generated by your site.



Task #5 – Options

The United States and other nuclear countries have designed, built, maintained, and currently dismantled nuclear weapons within a large complex of facilities. Most of the nuclear facilities were constructed during the heydays of the "Manhattan Project and the Cold War.", the 1940's and 1950's. These facilities are aging, contaminated with radioactive wastes from decades of nuclear research and development projects, and existing in a period of time where the U.S. Department of Energy is closing and consolidating sites while at the same time modernizing others. The Department of Energy has, as a result of new laws passed during the last decade, begun a plan to alleviate the environmental, health, and safety (ESH) hazards resulting from these years of weapons development, production, and testing.

During the process of declassifying and cleaning up of former nuclear sites, the Department of Energy has realized the magnitude of the contamination. The severity and types of contamination vary greatly as does the types of waste. Contaminated soil, stored and buried transuranic, low level, and mixed wastes, and sometimes hazardous organic materials have moved beyond the boundaries of some facilities. The process of cleaning up the wastes has begun. New methods and technologies are being developed to attack the problem. But questions still arise. What do we do with the wastes? How do we mitigate the potential hazards for the general population as we begin to transport and store these wastes? These are perplexing problems faced by the Department of Energy. Past, current and future wastes must be contained, moved and stored, all within the limits of the law.

Federal laws require the Department of Energy to enter into several types of legal compliance agreements with the Environmental Protection Agency and state regulators. These agreements set procedures and schedules for meeting regulatory requirements. The laws and agreements have been established to ensure that the government acts to carry out existing and evolving policies set by Congress.

The Department of Energy has set a 30 year goal to clean up and restore the environment at its nuclear sites. Although considered unrealistically short, new technologies are being developed to help reach the mandate set by Congress.

Our fifth task focuses on the options regarding the storage and disposition of radioactive waste. To understand these options and their impact, we need to investigate them from the perspectives of science, the various government entities and their represented constituencies, the environmental, health and safety issues, and international acceptance.

Your task is to compare and contrast the different options for storage and disposition of radioactive wastes at the international, national, regional, and state levels. You must examine differing approaches regarding the transportation, storage, and disposition of radioactive wastes. Scrutinize the impact of each option within the context of the four domains (science, economic, social/cultural, and political/geo-political). Research and gather data that help you build an understanding of the laws and regulations.

This task focuses on identifying options for the storage and disposition of radioactive wastes. Using this as your reference point, address the following:

- 1.** Select one option for each of the following. Justify the use your selected option compared to other options.
 - treatment of radioactive wastes to reduce hazards
 - storage of radioactive wastes
 - disposing of radioactive wastes
- 2.** Develop a magazine article, replete with pictures, graphics, charts, and graphs, describing each of the options you selected above. Assume the article will be printed in a widely subscribed science magazine for the lay population. Criticize and defend each option.
- 3.** Propose an alternative for the disposition of excess plutonium from dismantled nuclear weapons that could be implemented by all of the nuclear states.



Suggested Classroom Activities for Task #5

The following activities and questions are "hooks" for the work which is to come. While they are intended to generate discussion and promote understanding of and interest in the task, they are not directed specifically at any task question.

This task focuses on options for storage and disposition of radioactive waste. Using this as your reference point, address the following:

- 1.** Identify and describe options for treating radioactive wastes. Create a chart giving the pros and cons for each option.
- 2.** Design and develop a traveling display to inform the public of the options for treating radioactive wastes. One part of the display should promote the Department of Energy's research and development, successes, and future methods while another part should promote the skepticism of an anti-nuclear group on these options.
- 3.** Hold a class discussion on the hazards/benefits, strengths/weaknesses of storing radioactive wastes in your state.
- 4.** Identify options for storing radioactive wastes. Describe possible reasons for each option.
- 5.** Identify options for disposing of radioactive wastes. Describe possible reasons for each option.
- 6.** Identify the methods currently being considered for the disposition of excess nuclear weapons grade material.
- 7.** Hold a class discussion on different options, and the impact of each within the four domains. Which option seems to be the best from your class discussion?



The Future of the Nuclear World

Introduction

Reducing the Nuclear Danger is the mission of Los Alamos National Laboratory (LANL). Additionally the Laboratory has initiated a project to examine a variety of nuclear related areas in the future some twenty to fifty years from now. The effort, known as the Nuclear Vision project, seeks to define a vision for the future which can simultaneously reduce nuclear dangers while allowing benefits from nuclear technologies to be realized. In creating such a vision, the effort examines pathways leading to them and seeks to identify steps that could begin in the near future to realize such visions. Of particular interest is identification of technologies and their possible impacts on important nuclear-related areas of the future. The scale of this effort is to address issues and circumstances of international, national, and local (Laboratory) impact and interest.

A guiding principle of our efforts is perhaps best expressed by University of California, Santa Cruz, Professor John Schaar: "The future is not a result of choices among alternative paths offered by the present, but a place that is created-created first in mind and will, created next in activity. The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination."

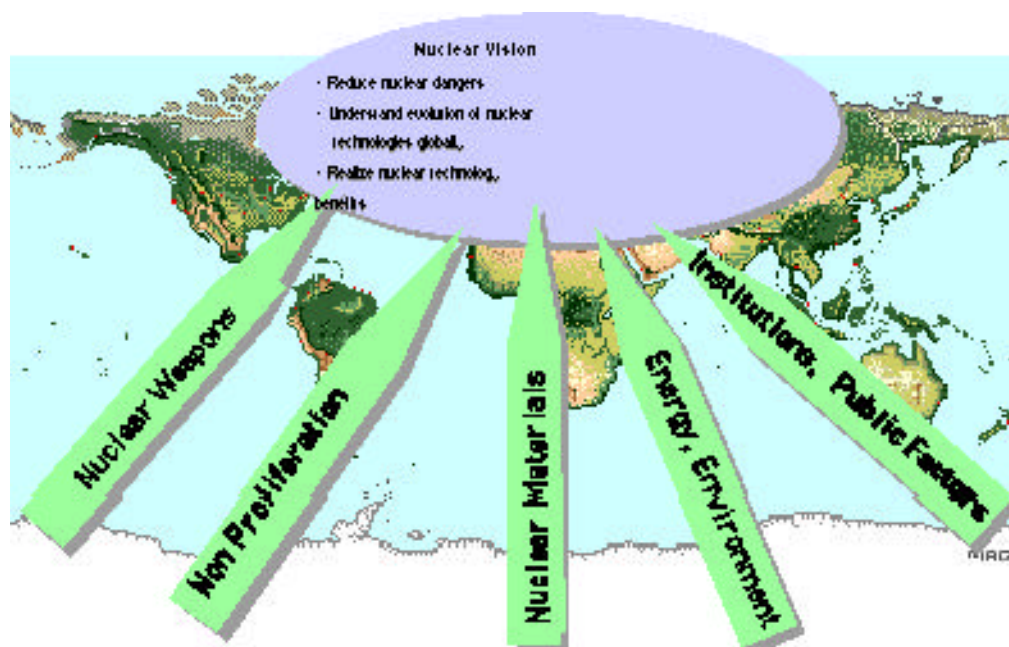
A little over 50 years ago, work at Los Alamos and elsewhere in the world set in motion developments in military and civil applications of nuclear science and technology. Over the years these ongoing developments have shaped history. The resulting "Nuclear Age" has had a significant impact on many aspects of society -- nationally and internationally.

Dramatic global political changes, including the end of the Cold War, have provided both opportunity and incentive for a thoughtful examination of the future of the global nuclear enterprise. The Global Nuclear Vision Project at Los Alamos National Laboratory is intended to explore how the evolution of "things nuclear" might progress over the next half century. These include the future of nuclear energy and other civil applications; nuclear weapons and proliferation; the institutions associated with, and public opinions about, nuclear science and technology; and environmental and other related issues.

The Nuclear Vision Project can be important to national, international, as well as Laboratory interests. The areas (listed above) that will be examined are a complex mixture of technology, institutional factors, and policy decisions. To provide mechanisms for obtaining knowledgeable information from a variety of sources, the Project will use a

series of workshops and research efforts, coupled with interactions with acknowledged centers of expertise.

Our attempts to create a "global vision" are, of course, motivated by the practical need to tie long-range objectives back to near-term actions and decisions through achievable steps and milestones. Any such global vision must seek a balance between minimizing the dangers and maximizing the benefits of the wide variety of nuclear technologies being pursued around the world. Pictorially this theme is shown below.



A second principle guiding our efforts is perhaps best expressed by University of California, Santa Cruz, Professor John Schaar: "The future is not a result of choices among alternative paths offered by the present, but a place that is created-created first in mind and will, created next in activity. The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination."

At the same time, we must consider these words in the context of certain realities that carry implications for the future: the increasing demand for nuclear energy in east Asia, the growing global inventories of nuclear materials, an increasing demand for energy coupled with the finiteness of many current fuel sources, the reduction of superpower stockpiles, the increasingly rapid diffusion of technical knowledge and capabilities across

the globe, and the risks of nuclear weapons proliferation and of proliferation of other weapons of mass destruction. Exactly where these current situations may lead is, of course, not known, but it is certain that the future will be shaped both by unanticipated events and intentional actions. Our task, then, is to think broadly about what is desirable and possible without abandoning the realm of possibility for that of fancy.

In this spirit, the Global Nuclear Vision Project does not attempt to predict the future but rather to explore alternative futures and their implications. In doing so, we hope to gain a deeper understanding that will guide our own actions as well as provide information relevant to current and future policy dialogues. We've chosen to address a nominal 50-year horizon, a realistic boundary given that technology development and implementation generally takes decades, the energy industry plans at least two or three decades ahead, and individual military systems, including ships, aircraft, and nuclear weapon, can remain in inventory for several decades.

Goals of the Project

Over 70 percent of Los Alamos National Laboratory's effort is associated with nuclear science and technology, including stewardship and support of the US nuclear weapons stockpile, nonproliferation activities, environmental technology, nuclear materials research, basic nuclear science, and energy technologies. No set of institutions span a broader scope of nuclear science, technology, and applications than do the suite of Department of Energy national laboratories. The Project's aim is to help build an improved understanding of the present role and potential future roles of nuclear science and technology, within Los Alamos, in other institutions, and in society. That understanding could help create a more coherent whole from interrelated, diverse applications of nuclear technology. The nation would also be strengthened by a better long-range view of the broad integration of nuclear science and technology and their applications.

Superb science is an essential ingredient in the execution of the Laboratory's core missions. Indeed, one role of a national laboratory is to aim applications of science beyond the natural time horizons that limit other types of institutions. The Global Nuclear Vision Project can help link today's science to potential future applications and issues and improve understanding of the technological/societal/geopolitical events that may drive the need for such science.

Elements of the Project

The Los Alamos Global Nuclear Vision Project consists of three elements-internal and external workshops, internal Los Alamos research and analysis projects, and efforts to

link work at the Laboratory with synergistic efforts throughout the United States and the world. Understanding and consensus on complex and interrelated global nuclear issues are the intended products of the project, and its success will be measured by how and whether the fruits of the Project impact actions and decisions. The media for this dialogue will be discussions in many forms -- published and informal.

The Workshops.

The Project began in August 1995 during a two-day workshop entitled, "Securing the Nuclear Future." Twenty-five members of the Los Alamos staff attended, and an equal number of experienced people from outside the Laboratory were invited, including participants from other nations. A second workshop, "Nonproliferation and International Security," was held in November 1995, and a third, "Nuclear Weapons and Stewardship Issues," in April 1996.

Planned events include a workshop on global nuclear energy and nuclear materials futures later this year. We plan to host at least one other workshop plus a final meeting to synthesize the work of previous workshops into a coherent vision statement. Important to our immediate plans will be a forum (tentatively set for late 1996 or early 1997) to discuss the Project and to receive public input.

Each workshop is designed to include the contributions of qualified experts who bring to the table a broad spectrum of perspectives and opinions ranging from general support of the benefits of nuclear technology to legitimate concerns about present and future nuclear activities.

Research and Analyses.

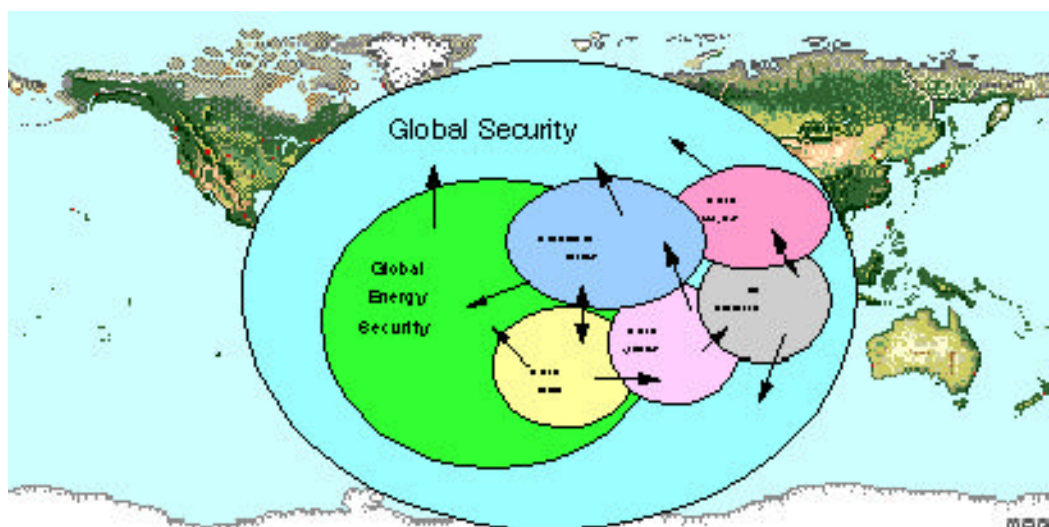
The second element of the Project, research and analyses, is supported using a small fraction of the Laboratory-directed Research and Development funds which are earmarked for long-range or forefront technology investigations. A few people supported by such funds are pursuing research and analysis on topics of direct importance to the Project. Examples include modeling of global energy needs, nuclear power scenarios, and resulting nuclear material inventories and flows; assessment of the impacts of nuclear technology developments on global nuclear materials inventories; exploration of the long-term implications of the global spread of technology, including nuclear power, for global nuclear weapon development capabilities; and identification of potential roles of nuclear weapons in future security environments.

Links to Related Efforts. A great deal of work relevant to the Nuclear Vision Project is being conducted outside the Laboratory, and we are fortunate in that we can build upon

the many established relationships. We are developing collaborations with appropriate individuals and groups throughout the US and internationally. In particular, we seek to broaden our relationships with the University of California through collaborative activities between the Laboratory and the Institute on Global Conflict and Cooperation (San Diego), the Center for Nuclear and Toxic Waste (Berkeley) as well as other UC sites and departments.

Pivotal Issues

Complex issues emerge almost immediately as one begins to think about global nuclear structures, the ways in which we might face the current and future nuclear realities of the world, and the best ways to minimize nuclear dangers while gaining benefits from nuclear technology. Identifying and understanding connections between the nuclear arena examined by this Project and other environments such as the ones shown here are key.



Although we are still in the early stages of the project, here are a few examples of the questions we have identified for further study.

What are salient features of future global nuclear weapons regimes (the context and defining features associated with nuclear weapon capabilities around the world)? How might future regimes evolve in the complex post Cold War international environment?

What are the linkages and tradeoffs associated with future global energy security -- including meeting energy and economic growth needs of developing nations -- and

nuclear power? How does the need to counter negative environmental factors such as increased carbon emissions from fossil fuels impact such relationships?

What is the nature of the relationship between the growing global inventory of nuclear materials and future dangers associated with proliferation of nuclear weapons? Will extensions of current safeguards for nuclear materials suffice? Could an inventory reduction strategy be applied? What technologies and institutional means would be attractive?

Could the spread of civilian nuclear technology create, over the long term, a condition of widespread "latent" nuclear weapon capabilities with attendant possibility of widespread proliferation races? What could be key triggers to such events? How could such situations be ameliorated?

What is the role of plutonium in future global nuclear energy scenarios? What technologies can prove effective in managing plutonium-both to utilize its energy content and minimize inventories that must be stored for eons?

Finally a key question most relevant for Los Alamos and other government institutions is what new science and technology should be explored to increase future options, especially in nuclear environments.

March 17, 1996 was the 50th anniversary of the Acheson-Lilienthal Report, which began efforts to place all applications of nuclear science and technology under international control. Such international control did not come to pass. During the ensuing 50 years, a fabric related to nuclear affairs, civil and military, has been woven from threads of bilateral, multilateral, and international arrangements. The implications for mankind of the potential-for good and ill-of the energy of the nucleus of the atom are still global, indeed more so today than in 1946. The fact that this potential will continue to be a major issue in world affairs is the driver for the Global Nuclear Vision Project.



Task Assignments for the Future of the Nuclear World

Task #1 – Current Nuclear Events

“The world that we have made as a result of the level of thinking that we have done so far, has created problems we cannot solve at the level of thinking at which we created them.”

- Albert Einstein

On March 17, 1946, the Acheson-Lilenthal Report was submitted to begin efforts to place all applications of nuclear science and technology under international control. Such international control has not come to pass. During the ensuing 50 years, a fabric related to nuclear affairs, civil and military, has been woven from thread of bilateral, multilateral, and international arrangements. The implication for mankind of the potential - for good and ill - of the energy of the nucleus of the atom are still global, indeed more so today than in 1946.

A little over 50 years ago, work at Los Alamos and elsewhere in the world set in motion developments in military and civil applications of nuclear science and technology. Over the years, these ongoing developments have shaped history. The resulting "nuclear age" has had a significant impact on many aspects of society - nationally and internationally.

To help us gain an understanding of the nuclear world and its future, we must begin to investigate current events and realities and how they affect our world today. You will investigate a variety of issues focusing on treaties, nuclear materials, nuclear weapons, and nuclear power and how the four domains (science, economics, politics, and social/cultural) impact decisions and behaviors.

As you begin to think about the future of the nuclear world, your task is to consider issues surrounding the current realities of the nuclear world. Within the framework established for this program, develop a multi-layered response discussing the varying perspectives in regard to the current realities and how they shape the world today.

The following Task is designed to help you synthesize historical material while considering current nuclear age realities. You are tasked to prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is analyzing issues

surrounding the nuclear world. You are to research, gather data, and thoroughly demonstrate your understanding of the foundations of the current nuclear world.

1. Develop a multi-layered response discussing varying perspectives in regard to current realities and how they shape the world today. You may approach the task from one or more of the following specific areas:

- Issues dealing with negotiated treaties - compliance, non-compliance, etc.
 - Issues dealing with disarmament - compliance, safety, storage, smuggling, etc.
 - Issues dealing with disposition of excess nuclear materials – disposal sites, disposal methods, regulations, etc.
 - Issues dealing with nuclear power - construction of nuclear power plants, regulations, nuclear fuel, etc.
 - Issues dealing with environmental contamination and restoration
-

Suggested Classroom Activities for Task #1

- 1.** Conduct an international debate on the impact of living with the atomic bomb. Have students research varying nations and discuss the impact of the bombs existence within the four domains (science, economics, politics, social/cultural).
 - 2.** Have students find articles on current research being conducted at the national laboratories (these may be newspaper, magazine or Internet articles). Organize the articles by the scientific focus and create a list of the science concepts being studied. What impact does the research have on the local, regional and national communities.
 - 3.** Research the varying negotiated treaties dealing with the nuclear world. Look at how compliance, non-compliance, etc. is determine and dealt with.
 - 4.** Have student debate the unilateral disarmament issue. Have students develop varying scenarios of anti-nuclear activist practices in different countries within the context of the four domains (science, economics, politics, social/cultural).
 - 5.** Have students identify sources of nuclear materials. Dialogue issues dealing with disposition of excess nuclear materials within the context of the four domains (science, economics, politics, social/cultural). Research and discuss disposal sites, disposal methods, regulations, etc.
 - 6.** Have student look at issues dealing with nuclear power within the context of the four domains (science, economics, politics, social/cultural). Research and discuss construction of nuclear power plants, regulations, nuclear fuel, etc.
 - 7.** Have students research issues dealing with environmental contamination and restoration.
 - 8.** Invite guest speakers to discuss the impact of the nuclear world on their "personal work world" (business, educators, scientists, farmers, news media, etc.). Discuss spin-off products, national and international relations, security issues, the end of the "Cold War Era", etc. Have students prepare questions prior to the visit and have them keep records from the conversations.
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Task #2 – Future World Environments in General

"The future is not a result of choices among alternative paths offered by the present, but a place that is created - created first in mind and will, created next in activity.

The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination."

- Professor John Schaar (University of California, Santa Cruz)

The following task assignment is designed to allow you to speculate about what the world might look like 20 to 50 years from now. You are expected to approach the assigned tasks from different geopolitical perspectives and to develop responses to the tasks that reflect interaction between these different perspectives.

The Global Nuclear Vision Project does not attempt to predict the future but rather to explore broadly alternative possible futures and their implications. In doing so, we hope to gain a deeper understanding that will guide our own actions as well as provide information relevant to current and future policy dialogues. We've chosen to address a nominal 50-year horizon, a realistic boundary given that technology development and implementation generally takes decades, the energy industry plans at least two or three decades ahead, and the individual military systems, including ships, aircraft, and now nuclear weapons systems, can remain in inventory for several decades as well.

As we ponder the future, we realize that our present and future endeavors are built upon the experiences of the past. As we begin to speculate about the future, we need to step back for a moment and reflect on the changes that have occurred during the past centuries, especially the last 50-100 years. As A.S. Eddington stated,

"...our eyes once opened,... we can never go back to the old outlook....But in each revolution of scientific thought new words are set to the old music, and that which has gone before is not destroyed but refocused."

To help us gain an understanding of the nuclear world and its future, we will begin to investigate the nuclear world in general. You will investigate a variety of issues focusing on treaties, nuclear materials, nuclear weapons, nuclear power, and nuclear medicine and how the four domains (science, economics, politics, and social/cultural) impact the acceptance or rejection of nuclear processes.

Your task assignment is to speculate about what the nuclear world might look like 20 to 50 years from now. You are expected to approach the assigned task from different geopolitical perspectives and to come up with responses that reflects interaction between these different perspectives. You are to explore broadly alternative possible futures and their implications.

As you work on this task, keep the following in mind.

1. What is the "big picture"? What are the boundaries for the task?
2. Focus in on the "big picture". What are the parts/components necessary for completing the task? How are these parts/components related? Assign values/criteria to each part/component to determine priority levels.
3. What action can you take? How are you going to explain your position/decision?
4. Refer to the handouts on critical thinking, intellectual standards, and Socratic teaching.

The following Task is designed to help you synthesize research material while considering future nuclear world scenarios. You are tasked to prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is analyzing issues surrounding the future of the nuclear world. You are to research, gather data, and thoroughly demonstrate your understanding of the foundations of the current nuclear world and how they might play out in the future.

In developing a vision for the future, we need to consider the past and current realities of the world in general. Within the framework established for the program,

1. Develop a multi-layered response discussing your vision in regard to the possible future realities and how they may shape future policy decisions.
2. Develop several scenarios that could globally or regionally describe world environments and justify each of your developed scenarios. (You may want to consult with community members to get a well-rounded perspective on critical issues that shaped previous global change. You should consider the following areas:
 - Personal beliefs as to what the world might look like in 20-50 years and why
 - The nature of relations among nations and the role of the US in such a world
 - Views on Asian, European and Middle Eastern scenarios and their impacts on world futures

Suggested Classroom Activities for Task #2

- 1.** Have students investigate and compare countries that have nuclear capability (power plants, weapons, medicine, technology) with those that do not have nuclear capability within the context of the four domains (science, economics, politics, social/cultural). Discuss the advantages or disadvantages of being a nuclear capable country.
 - 2.** Have students investigate the legacies of the "Cold War" as it pertains to nuclear capability. Where and what are the "Hot Spots"? What effect (positive or negative) has the development of a nuclear capacity (power, weapons, medicine, technology) had on human, animal and plant life?
 - 3.** Have students investigate the advances within the scientific domain within the last 100 years. How are these advances being used today? In what direction are these studies leading?
 - 4.** Discuss how scientific advances of the last century have helped or hurt world economies.
 - 5.** Discuss the role of different countries in world government before and after the development of the nuclear bomb. How does the shift of power correlate with the advances in nuclear physics? Discuss the roles of the haves and have nots (nuclear capability) in the realm of world government and decisions that affect all countries.
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Task #3 – Future World Environments, specifically energy

"For decades it has been clear to the scientific community that nuclear energy is destined to play an ever-increasing role for the generation of electricity throughout the world. Yet here in America, the birthplace of commercial nuclear energy, the promise and production of this technology has been brought to a near halt. Why?"

From the Foreword to "America the Powerless"
Dr. Glenn T. Seaborg (Nobel Laureate, 1951)

This task is designed to allow you to continue speculating about what the nuclear world environments might look like 20 to 50 years from now, specifically in the area of energy.

The energy sources that have fueled our industrial growth over the past two centuries are under attack for environmental concerns. Research has investigated a number of new approaches that may be able to replace our dependence on the fossil fuels we now use. Approaches being considered and areas in which research is being conducted include nuclear (fusion and fission), solar, wind, and hydrogen fuel cells. Each have their pros and cons.

As we ponder future energy needs, we realize that our present and future endeavors are built upon the experiences of the past. We recognize that the world's future energy use is all encompassing and that we need to approach energy use issues in more manageable areas of research. This task specifically focuses our efforts of the world developed in Task #2 onto the general areas associated with energy needs for economic development, environmental issues, the role of science and technology. You will address the energy issues in regard to their part in future decision making throughout the world.

Your task assignment is to speculate about the energy needs of the nuclear world 20 to 50 years from now. You are expected to approach the assigned task from different geopolitical perspectives, to collect appropriate data and come up with responses that reflect interaction between these different perspectives. You are to explore broadly alternative possible futures and their implications.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing different sources of energy and production methods.

In developing an understanding of the energy needs of human societies, we must look at the past, present, and projected future as we begin to narrow our research efforts toward specific areas of concern.

1. Develop a team vision in regard to the possible future world environments focusing specifically on energy issues and how they may shape future policy decisions.

Develop several scenarios that could globally or regionally describe world environments and justify each of your developed scenarios. You may want to consult with community members to get a well-rounded perspective on critical issues that shaped previous global change. You should include the following areas:

- Situations regarding future energy needs, particularly those occurring in rapidly developing nations
- Issues of the environment (i.e. global climate change, acid rain, etc.) along with steps to mitigate these problems
- Include ideas on areas where technology can have important impacts in the areas listed above or in other areas that will be key components of life in the future.



Suggested Classroom Activities for Task #3

- 1.** Have the students conduct research on energy for different types of human endeavor (production of food, production of heat and electricity, mining and processing raw materials, etc.)
 - 2.** Discuss whether a mix of sources and systems needed to meet future world energy needs will (could) exist at sufficient levels.
 - 3.** Examine the possibilities for movement from dependence on fossil fuels to other sources such as renewables (i.e., solar, wind, biomass, and nuclear power). Have students report out on the pros and cons of each type of fossil fuel energy source (renewable and nonrenewable).
 - 4.** Examine the roles of innovative technologies in energy production (i.e., improved photovoltaics, new nuclear technology, etc.) Have students discuss the viability of each technology and whether current human endeavors would finance such technology.
 - 5.** Examine the role of technology in energy use (i.e., electric cars, hydrogen as a fuel, etc.) Have students break into teams, each team taking an opposing view, and hold an academic dialogue on each technology with each team justifying their viewpoint.
 - 6.** Examine the issues in different geopolitical areas of the world where nuclear power currently plays or might play an important role in meeting their future energy needs. Discuss how the general population acts/reacts to the introduction of nuclear technology. Consider emotions, facts, energy needs, the environment, economics, etc.
 - 7.** Have students examine and discuss issues associated with future applications of nuclear power (i.e., safety, proliferation, pollution, waste management, etc.) Hold a debate where one side makes judgements based on emotion and the other on facts.
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Task #4 – Role of Things Nuclear in Future World Environments, specifically weapons

"Should a President, in the event of a nuclear attack, be left with the single option of ordering the mass destruction of civilians, in the face of the certainty that it would be followed by the mass slaughter of Americans? Should the concept assured destruction be narrowly defined and should it be the only measure of our ability to deter the variety of threats we may face?"

- President Richard M. Nixon, 1972

The development of the atomic bomb and the subsequent development of the hydrogen bomb and numerous design refinements over the past 50+ years has been a highly debated issue throughout the world. A nuclear arms race developed between the former USSR and the United States. Vast amounts of capital were expended and a huge industrial complex was created during this time. The world was under the veil of a "Cold War" with each side trying to keep the other from having a perceived military advantage over the other. The world was able to go through 50 years of relative "peace" with "minor regional" skirmishes between nations, but no "World War III". Detente was the buzzword for the time period. The question remains and is still being debated. Do nuclear weapons prevent war? This task specifically focuses the pictures of the world developed in Task #2 onto general areas associated with the role of nuclear weapons on future world environments. You will address issues in regard to how nuclear weapons will impact future decision making throughout the world.

Your task assignment is to speculate about the impact nuclear weapons will have on the decision making process in the nuclear world 20 to 50 years from now. You are expected to approach the assigned task from different geopolitical perspectives, to collect appropriate data and come up with responses that reflect interaction between these different perspectives. You are to explore broadly alternative possible futures and their implications.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing different sources of energy and production methods.

In developing an understanding and a vision for the future of arsenals that include nuclear weapons, we must look at the past, current realities, and projected future as we begin to narrow our research efforts toward specific areas of concern.

1. Develop and discuss a vision in regard to the possible future world environments focusing specifically on the role of nuclear weapons and how they may shape future policy decisions.
 2. Develop several scenarios that could globally or regionally describe world environments and justify each of your developed scenarios. You may want to consult with community members to get a well-rounded perspective on critical issues that shaped previous global change. You should consider the following areas:
 - Whether ways will (could) exist to control armed conflict in future global or regional societies, such as a move toward a world government, a resurgence of nationalism, and the importance of ethnic and historical factors governing such issues.
 - Examine the areas of nuclear weapons with emphasis on trends in nuclear weapons arsenals in the future, looking at START II, in terms of numbers, rapid disarmament, regrowth in numbers of weapons
 - Examine the areas of nuclear weapons with emphasis on trends in the number of nations having nuclear weapons beyond the U.S., (China, Russia, Great Britain, France, India, Pakistan) plus the undeclared weapon states (Israel)
 - Examine the areas of nuclear weapons with emphasis on roles for nuclear weapons, deterrence to other nuclear weapons, national prestige, deterrence to chemical and biological weapons use.
-

Suggested Classroom Activities for Task #4

- 1.** Have the students identify national security issues for the United States. Make sure they consider issues in the context of the four domains (science, economics, politics, social/cultural).
 - 2.** Have students consider national security issues from the perspective of different countries again within the context of the four domains.
 - 3.** Hold a "United Nations" debate where students assume roles of delegates from different countries and defend their countries national security positions.
 - 4.** Examine the roles of nuclear weapons spinoff technologies in business and medicine. Have student s discuss the viability of each technology and whether current human endeavors would finance such technology for a safer future.
 - 5.** Examine the role of diplomacy in maintaining a nuclear arsenal. Have students break into teams, each team taking an opposing view, and hold an academic dialogue with each team justifying their viewpoint.
 - 6.** Examine the issues in different geopolitical areas of the world where nuclear arsenals currently plays or might play an important role in the decision making process. Discuss how the general population acts/reacts to a countries nuclear capability. Consider emotions, facts, energy needs, the environment, economics, etc. nuclear weapons development (i.e., safety, proliferation, pollution, waste management, etc.) Hold a debate where one side makes judgements based on emotion and the other on facts.
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Task #5 – Role of Nuclear Things in Future World Environments, specifically medical, industrial, and other applications

"Working with plutonium and other radioactive materials while limiting radiation exposures remains at the heart of our mission just as it was during the Manhattan Project. Concurrently, maintaining public trust regarding environmental, health and safety issues has become ever more important to the success of our mission."

- Dr. Siegfried S. Hecker, 1995

Former Director, Los Alamos National Laboratory

It has been conjectured by some that, because biological organisms evolved in the presence of low levels of ionizing radiation, we and other life forms must have developed effective mechanisms to repair the damage caused by this exposure. Others contend that even the lowest levels of radiation have the potential to cause serious biological effects, such as cancer or genetic disease.

In fact, no one knows for sure if low doses of ionizing radiation can produce serious biological effects on humans. What we do know is that high doses of radiation can produce such effects, and the risks can be quantified. From these known risks at high doses, one may estimate the risks associated with low doses, based on some procedure of extrapolation. Disagreement about such a procedure for extrapolating from high doses to the low doses that are of practical concern to radiation workers and the general public lies at the heart of much of the controversy surrounding potential human radiation effects. In the end, such extrapolations from high doses to low doses are based on theoretical biophysical considerations convenience of application but not on hard human data.

This task specifically focuses the pictures of the world developed in Tasks #2 and #3 onto general areas associated with the role of nuclear science and technology on future world environments. Students will address issues in regard to how nuclear science and technology will impact future decision making throughout the world.

Your task assignment is to speculate about the impact research in nuclear medicine will have on the decision making process in the nuclear world 20 to 50 years from now. You are expected to approach the assigned task from different geopolitical perspectives, to collect appropriate data and come up with responses that reflect interaction between these different perspectives. You are to explore broadly alternative possible futures and their implications.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing different applications of nuclear physics in the realm of medicine, business and home applications.

In developing an understanding and a vision for the future of nuclear medicine and businesses designing and selling equipment using nuclear technology, we must look at the past, current realities, and projected future as we begin to narrow our research efforts toward specific areas of concern.

1. Develop and discuss a vision in regard to the possible future world environments focusing specifically on the role of nuclear science and technology, specifically nuclear technologies and their use in medical, industrial and home applications and how they may shape future policy decisions.

2. Develop several scenarios that could globally or regionally describe world environments and justify each of your developed scenarios. You may want to consult with community members to get a well-rounded perspective on critical issues that shaped previous global change. You should consider the following areas:

- Examine the role of nuclear science and technology in medical applications
- Examine the role of nuclear science and technology in industrial and home applications
- Examine the controversial applications of nuclear science and technology in such areas as food preservation, sewage sterilization, nuclear waste disposal, etc.



Suggested Classroom Activities for Task #5

- 1.** Have the students identify uses of nuclear physics in medicine. Have students consider and discuss issues surrounding nuclear medicine in the context of the four domains (science, economics, politics, social/cultural).
 - 2.** Have students identify various industrial uses of nuclear materials and its impact on human societies. Have student discuss the differences in the needs of business and government in regard to nuclear technologies.
 - 3.** Identify nuclear weapons spinoff technologies in business and medicine and home applications. Have students discuss the viability of each technology and whether current human endeavors would finance such technology for a safer future.
 - 4.** Examine the role of diplomacy in maintaining a nuclear medicine capability. Have students break into teams, one team taking the role of a nuclear capable country intent on keeping "all nuclear technologies" an opposing view, and hold an academic dialogue with each team justifying their viewpoint.
 - 5.** Examine the issues in different geopolitical areas of the world where the need for nuclear medicine is not currently available. How might representatives make decisions toward the pursuit of these technologies. Discuss how their general population would acts/reacts to their countries pursuit of a nuclear capability. Consider emotions, facts, energy needs, the environment, economics, etc.
 - 6.** Have students examine and discuss issues associated with future applications of nuclear technologies development (i.e., medical equipment, medical techniques, safety, proliferation, pollution, waste management, etc.) Hold a debate where one side makes judgements based on emotion and the other on facts.
-

Task #6 – Public Attitudes and Institutional Responses to Technology in the Future with Emphasis on Nuclear Things

"It is important not only that citizens have roles in deciding how things will be done, but also that they contribute to the process of making things happen, addressing significant problems rather than delaying action indefinitely. Deciding when action is called for is sometimes the most difficult decision. Those who have faith in the democratic process believe that the public will help insure that the right decisions are made about how and when to act"

"League of Women Voters"

1993

"I know you believe you understand what you think I said, but I am not sure you realize that what you heard is not what I meant!"

Anonymous

"What lies behind us and what lies before us are tiny matters compared to what lies within us."

Ralph Waldo Emerson

The following task is designed to allow you to examine trends that lead to some increasing distrust of science and technology with an emphasis on nuclear technology areas and whether such trends might continue into the future. You are expected to approach the assigned task from different geopolitical perspectives and to come up with responses that reflect interaction between these different perspectives.

Communication is a vital aspect between those that are doing science and those that benefit or are harmed by science. It is through faulty communication that mistrust is bred. Science has become known as the subject area that is hard to understand. For whatever reason this idea has spread, the importance of communication between scientist, politicians and the general populace has grown. If we are to move into the future, we must alleviate as much mistrust as we can.

This task specifically focuses the pictures of the world developed in previous tasks onto general areas associated with the public view, attitudes and institutional responses to the role of nuclear science and technology on future world environments. You will address issues in regard to how nuclear science and technology is viewed and how these views and attitudes impact future decision making throughout the world.

Your task assignment is to speculate about the impact the public will have on future nuclear research and how the public will impact the decision making process in the nuclear world 20 to 50 years from now. You are expected to approach the assigned task from different geopolitical perspectives, to collect appropriate data and come up with responses that reflect interaction between these different perspectives. You are to explore broadly alternative possible futures and their implications.

You must prepare a series of researched responses to the tasks listed below, within the context of the four domains (science, economics, politics, and social/cultural). The focus of these tasks is comparing historical and current responses from the general public toward nuclear physics research and application of nuclear technology in the realms of power, weapons, medicine, business and home applications.

In developing an understanding and a vision for the future of nuclear research and application of nuclear technology, we must look at the past, current realities, and projected future as we begin to narrow our research efforts toward specific areas of concern.

- 1.** Develop and discuss a vision in regard to the possible future world environments focusing specifically on public attitudes and institutional responses toward the role of nuclear science and technology and how they may shape future policy decisions. This effort would examine whether recent trends that lead to some increasing distrust of science and technology would continue in the future.
- 2.** Develop and conduct a public survey that would emphasize nuclear technology but would also include other new technology areas. Produce a detailed report on your interpretation of the results from the survey. You may want to consult with community members to get a well-rounded perspective on critical issues that shaped previous global change. You should consider the following areas:
 - Examine historical and current public perspectives that predict possible futures (i.e., Nuclear Fear by S. Weart, America the Powerless by Dr. Alan E. Waltar)
 - Examine the underlying drivers affecting public perspectives on nuclear science (nuclear weapons destruction, fear of radiation, small probability but large consequence accidents, proliferation of nuclear weapons, terrorism, etc.)
 - Examine the role that national and international media plays in the development of public attitude and understanding

Suggested Classroom Activities for Task #6

1. Have the students identify areas of concern from the public's point of view regarding nuclear waste disposal/transportation/storage. Create a pro/con/compromise chart addressing the issues identified. Assign students a role based on the chart (pro/con/compromise) and hold a town-hall meeting debating an issue. Select an issue from below or create your own:

- local nuclear power plant - storage of nuclear rods
- transportation of spent nuclear rods to disposal site through your community
- planned opening of nuclear storage site near your community
- maintenance of the nation's nuclear weapon inventory
- dismantling of nuclear weapons at site outside of your community
- small discharge of radioactive tritium from research facility 50 miles downwind from your community
- obsolete nuclear medicine equipment at your local hospital
- planned tritium production facility to be added to a research facility near your community
- etc...

Remember to conduct your research and discussions in the context of the four domains (science, economics, politics, social/cultural)

2. Have students discuss the differences in the approaches taken by the government and by nuclear activist groups when informing the general populace on an identified issue.

3. Have students read America the Powerless by Dr. Alan E. Waltar. Hold a class debate with 1/3 the class taking the perspective advocated by Dr. Waltar, 1/3 advocating the perspective of an activist group and 1/3 taking a neutral stance.



Assessment Components

The rubric is a valuable tool that uses negotiable contracting for a formal assessment. Working together, the instructor and the students create a ratings chart that reflects the objectives to be learned within a given assignment. The rubric is a tool that combines the rankings (usually on a scale of 1 - 5) used to assess how well students understand each of the criteria with the most important ideas or concepts to be mastered in the lesson. Depending on whether a student performs higher or lower in a certain category, each level may also numerical gradations. The learner using the rubric can understand the importance of each objective based on its relation to the overall lesson. The rubric provides a more detailed understanding of the skills demonstrated within a lesson, project, or unit of study, unlike a traditional number or letter grade.

The following are examples of rubrics used to score student task responses and student presentations.

Task Rubric

Category	Poor	Improving	Adequate	Good	Superior
Content Understanding <ul style="list-style-type: none"> Clearly identifies and addresses the four domains in relation to the topic Demonstrates in-depth understanding of issues and ideas by providing relevant, specific and accurate examples Ideas are supported by research data Position encompasses multiple real world connections 	1	2	3	4	5
Communication <ul style="list-style-type: none"> Ideas clearly stated and justified with research Writing and presentation is clear and understandable Presents material in a logical manner The material is well organized Utilizes technology effectively 	1	2	3	4	5
Collaboration <ul style="list-style-type: none"> Works as a contributing member of the group Meets deadlines and completes assignments Stays on task in class 	1	2	3	4	5
Information Sources <ul style="list-style-type: none"> Evidence of multiple sources of information to support the model Uses appropriate sources of information Evidence of information collection 	1	2	3	4	5
Overall Presentation Rating =					

Presentation Rubric

Category	Poor	Improving	Adequate	Good	Superior
Content Understanding <ul style="list-style-type: none"> Clearly identifies and addresses the four domains in relation to the topic Demonstrates in-depth understanding of issues and ideas by providing relevant, specific and accurate examples Ideas are supported by research data Position encompasses multiple real world connections 	1	2	3	4	5
Communication <ul style="list-style-type: none"> Premises clearly stated and justified All aspects of the presentation are clearly documented and labeled Presentation development is documented The presentation is well organized The presentation is clear and understandable 	1	2	3	4	5
Use of Technology Skills <ul style="list-style-type: none"> Presents material in a logical manner Visual materials are concise, legible and appropriate Multi-media are effectively used 	1	2	3	4	5
Information Sources <ul style="list-style-type: none"> Evidence of multiple sources of information to support the model Uses appropriate sources of information Evidence of information collection 	1	2	3	4	5
Overall Presentation Rating =					